PROCEEDINGS

Fifty-First Annual Convention

OF THE

American Railway Bridge and Building Association

1946

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Proceedings of the

Fifty-First Annual Convention

OF THE

American Railway Bridge and Building Association

Held at

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September 17-19, 1946

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H. M. Harlow, Chesapeake & Ohio.....Richmond, Va.

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PROCEEDINGS

Containing a running story of the meeting; abstracts of all the addresses presented during the B. & B. sessions and of most of those read before the joint sessions with the Roadmasters' Association; and complete versions of all the technical committee reports.

"FULL steam ahead" is a term that aptly describes the vigor manifested by the American Railway Bridge and Building Association at its three-day annual convention held at the Stevens Hotel, Chicago, on September 17-19. This observation is in order because of the gratifying attendance at the meeting, the spirit of interest and enthusiasm manifested by those present, and the broad and constructive nature of the program, which included technical reports and addresses on subjects comprising a representative cross section of the many problems confronting bridge, building and water service men.

The success of this meeting is particularly significant in view of the fact that it was the first full-scale three-day convention held by the association since 1942, the meetings in the meantime having been restricted by war-time conditions to one-day sessions. Further enhancing the contrast of this year's meeting with those of the last few years were a number of supplemental features, including a large exhibit of bridge, building and water service equipment and materials, and a well-attended inspection trip to a recently completed Diesel maintenance and repair shop near Chicago.

Concurrent With Roadmasters

Establishing this year's meeting as one of the most unusual in the long history of the association was the fact that it was held concurrently with the annual convention of the Roadmasters' and Maintenance of Way Association, the activities of which were reported in detail in the October issue. As indicated in that report, the two associations held their regular sessions in separate rooms in the Stevens Hotel, but came together in a joint opening session and subsequently on several occasions to hear addresses on subjects of mutual interest.

The fact that the two conventions were held concurrently had the advantage of making it possible for members and guests of each association to attend sessions of the other of particular interest, and also for higher engineering and maintenance officers, many of whom were in attendance, to be present at both conventions at the same time. Another advantage of the concurrent meetings, as pointed out in the October issue, was the fact that they made possible a joint exhibit of manufacturer's products by the Bridge and Building Supply Men's Association and the Track Supply Association, which, in number of exhibitors and scope, exceeded any previous exhibit held by either of the associations.

To avail themselves of the unique opportunities afforded by the concurrent sessions and the exhibit, a total of 693 members and guests registered at the two meetings. The attendance was augmented by the fact that a number of technical committees of the American

Railway Engineering Association held meetings in Chicago during the convention week in order that their members might see the exhibit and attend specific sessions of the convention. Notwithstanding the large attendance, there is no doubt but that it would have been considerably larger if there had not been a dearth of hotel accommodations, the Stevens Hotel alone having rejected more than 200 requests for rooms.

The combined opening session of the conventions, as well as the other joint sessions held later, was presided over jointly by Neal D. Howard, editor, *Railway Engineering and Maintenance*, and president of the Bridge and Building Association, and Herman E. Kirby, assistant engineer, Chesapeake & Ohio, and president of the Roadmasters' Association. All separate sessions of the Bridge and Building group were presided over by Mr. Howard, assisted by Frank G. Campbell, assistant chief engineer, Elgin, Joliet & Eastern, and first vice-president of the association, and J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton, and second vice-president.

Those present at the various joint sessions of the two conventions heard words of greeting from J. B. Akers, chief engineer, Southern, and president of the A.R.E.A.; George B. Coffey, president of the Bridge and Building Supply Men's Association; and Lewis Thomas, secretary of the Track Supply Association, and director of exhibits for the two supply groups. They also heard a challenging opening address by E. M. Hastings, chief engineer, Richmond, Fredericksburg & Potomac, and other addresses by Major-General Carl R. Gray, Jr., vice-president, Chicago & North Western; Donald D. Conn, executive vice-president, Transportation Association of America; W. K. Wallace, chief civil engineer, London, Midland & Scottish; and L. G. Bentley, general safety agent, Chesapeake & Ohio. General Gray spoke on The "Boys" of Company A; Mr. Conn on Problems Ahead in Railway Transportation; Mr. Wallace on Reconversion and Recovery Problems on the British Railways; and Mr. Bentley on How the Chesapeake & Ohio Won the Harriman Gold Medal Award in 1945.

At the separate sessions of the Bridge and Building group, which were reserved exclusively for a discussion of current problems facing the bridge, building and water service forces of the railways, the program consisted principally of the presentation and consideration of eight technical committee reports and three addresses. The latter were presented by M. C. Hope, senior assistant sanitary engineer, in temporary charge of the Land and Air Carrier Section of the Sanitary Engineering division of the United States Public Health Service, who spoke on Federal Interest and Responsibility in Railway Sanitation; by J. C. Sherrick, partner, Holabird & Root, architects, Chicago, who spoke on Modern Architecture and Materials in Railway Building Construction and Maintenance; and H. I. Benjamin, vice-chairman, System Committee on Insurance, Southern Pacific, who spoke on Preventing Bridge, Building and Tunnel Fires.

The following subjects were covered by the eight technical committee reports: Adapting Turntables to Meet Modern Conditions; Methods of Cleaning Water Lines, Sewers and Drains; Developments in the Use of Off-Track Work Equipment; Methods of Improving the Strength, Durability and Wear Resistance of Concrete; Tools and Equipment for Bridge and Building Shops; Cause and Prevention of Personal Injuries to Bridge and Building Employees; Utility and Economy of Pre-Fabricated Buildings; and Servicing Facilities for Diesel Locomotives.

Published in full in the following pages are all the committee reports with brief abstracts of the discussions that followed their presentation. Also included are shortened versions of President Howard's opening address and of the addresses by Messrs. Benjamin, Hope and Sherrick, and brief abstracts of the addresses by Messrs. Hastings, Gray, Conn, and Bentley.

Special Events

The tempo of the convention was enhanced by a number of special events. One of these included the election of Charles A. Buford, executive vice-president, Chicago, Milwaukee, St. Paul & Pacific as an honorary member, and the presentation of honorary membership certificates to the three honorary members elected at last year's meeting, these being Ralph Budd, president, Burlington Lines; Charles E. Johnston, chairman, Western Association of Railway Executives; and Fred L. Thompson, chief engineer (retired), Illinois Central. The presentation of the honorary membership certificates was made by Armstrong Chinn, chief executive officer of the Alton, and a past-president of the Association.

Another special event was a banquet tendered to members of the two associa-

tions and their families by the Track Supply Association and the Bridge and Building Supply Men's Association, at which the attendance was 857 persons. A third such event was the inspection trip, made after the close of the convention, to the new Diesel shop of the Burlington at Clyde (Chicago), Ill., where a group including 50 members and guests was greeted by Edward Flynn, executive vice-president of the Burlington, and conducted through the facilities by representatives of the engineering and mechanical departments.

New Officers

In the election of officers for the ensuing year, Mr. Campbell was advanced from first vice-president to president; Mr. Hancock was advanced from second vice-president to first vice-president; E. H. Barnhart, division engineer, Baltimore & Ohio, Garrett, Ind., was advanced from third vice-president to second vice-president; W. F. Martens, general foreman, bridges, buildings and water service, Atchison, Topeka & Santa Fe, San Bernardino, Cal., was advanced from fourth vice-president to third vice-president; W. A. Huckstep, general building supervisor, Missouri Pacific, St. Louis, Mo., and a director, was elected fourth vice-president, and C. R. Knowles, superintendent water service (retired), Illinois Central, and Elise LaChance were re-elected treasurer and secretary, respectively. The new directors elected were: H. M. Harlow, assistant general supervisor bridges and buildings, Chesapeake & Ohio, Richmond, Va.; H. B. Christianson, assistant to chief engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago; and F. R. Spofford, assistant division engineer, Boston & Maine, Dover, N. H., (re-elected).

Eight subjects were selected for investigation during the year, as follows: Utilization of New Types of Materials in Buildings; Use of Laminated Members in Bridges; Unfilled Needs in Power Machines and Power Tools for Bridge and Building Work; Development and Training of Supervisory Personnel in Bridge, Building and Water Service Forces; Construction and Maintenance of Shop and Enginehouse Floors and Runways; Economies to Be Derived Through the Modernization of Obsolete Water Stations; Safety Measures to Protect Employees Within Buildings Against Fire and Accident; and Need for Inspection of Substructures and Underwater Foundations.

Enthusiastic over the success of its 1946 annual convention, and reflecting the feeling of those in attendance, the Executive committee of the association, meeting after the closing session, voted to hold its 1947 convention during the week of September 15, concurrent again with the annual meeting of the Roadmasters' Association.

Hastings Outlines the Problems Ahead

The address by Mr. Hastings at the joint opening session on Tuesday morning dealt principally with the task confronting the railroads in meeting intensified competition, and the part that maintenance of way and structures men can and must play toward accomplishing that task. Speaking of the need for improved service to satisfy the public, he said that "past performances are soon forgotten—the public lives in the present—they want to know, 'What have you now?', not what you have done—not what you may do at some far distant date, but what are you doing?"

Citing figures to show how railway operating costs are increasing, Mr. Hastings said that in the face of this situation the railroads must maintain their properties in better condition, and that the watchword must be to "prepare for higher speeds and greater safety with economy." This situation, he said, "calls for the best from every one of us. Every means that can be devised should be used to reduce operating and maintenance costs and to increase safety and efficiency."

He deplored the huge expenditures of public funds that are being made in the interest of competing forms of transportation "while our railways finance, build, maintain, operate and pay taxes on the property created out of private capital—our taxes going to help pay for part of the public utility that becomes our principal competitor, whereby all of the ideas of fair play, one of the fundamental principles of our Americanism of the past, are seemingly cast to the winds." Concluding, he urged his listeners to "let your voices be heard, your ideas known, your influence felt, and we shall yet overcome the obstacles and keep our rightful place in the transportation industry as it lies before us."

President's Address

Speaking at the opening session of the Bridge and Building group, President Howard called for the loyal, un-

derstanding support of all bridge and building men in the solution of the problems facing railway management, and, in turn, the support of railway management for the constructive efforts of the association. After reviewing briefly the problems facing the railway industry he said in part as follows:

"In all these things, the railroads need the wisdom and support of our association and of its individual members. To others on the railways falls the major responsibility in the solution of many of these problems, but we, individually and as an association, cannot slight our share. We must back our industry in its fight against unfair competition, inequitable regulation of and subsidies to other forms of transportation; we must help our industry build back to new and higher standards of comfort and safety; we must help meet the challenge of rising costs with new technological developments that will prolong the life of our structures, minimize interference with traffic, and increase the efficiency and economy with which every item of our routine work is carried out; and we must accept the responsibility of strengthening supervisory personnel within at least our own department, so that when our work is done, we can lay down our tools with the confidence that our work will go on in capable hands."

After expressing a high degree of satisfaction with the achievements of the association over the years in the interest of the railways, President Howard continued, in part:

"But I am not satisfied that most railway managements, or the railways as a whole, have given our association the support to which it is entitled . . . the result of this situation over the years has limited severely the effectiveness of our group—the scope of its work, the breadth and soundness of its studies and recommendations, and the range of its influence for good among the thousands of bridge, building and water service supervisory officers over the country—all of which is contrary to the best interests of the railroads.

"With adequate, alert, informed and aggressive supervision one of the factors vital to the solution of many of the problems confronting the railways, our association, grown to proper proportions and influence, can be of inestimable value in creating and developing that kind of supervision in the bridge, building and water service forces. But an inarticulate attitude toward our association on the part of railway managements—even though that attitude be benevolent—will not produce the results desired."

General Gray Lauds "Boys" of Company A

An outline of the organization and functions of the Military Railway Service formed the first part of General Gray's address on The "Boys" of Company A. This discussion was concluded with a detailed analysis of the organization, duties, personnel and equipment of the "A" Company of a Railway Operating Battalion, this company being equivalent to the maintenance of way department in a division superintendent's organization.

General Gray then traced the activities of the Military Railway Service from February, 1943, when 25 officers and men of headquarters, First M. R. S., were flown over the Atlantic as an advance echelon, opening headquarters in Algiers, North Africa, on February 9. The manner in which decisions were made and priorities issued for railway lines to be rehabilitated and operated by the M. R. S. was described. Pointing out that the reconstruction of demolished bridges was the principal task confronting the "A" companies in North Africa, General Gray described some of the problems encountered and the methods used in the work.

Regarding operations in Italy, General Gray said that, from the fall of 1943 to the summer of 1944, the "A" companies and assigned troops rebuilt more than 1,000 miles of track, constructed more than 15,000 feet of new bridging, and reconstructed 24 tunnels with a total length of 20 miles. Next, he gave essential information regarding some of the more interesting bridge reconstruction jobs in Italy, France and Germany.

After discussing the work performed by "A" company troops of the Second M. R. S. following the invasion of France across the English Channel, General Gray listed a number of enlisted men whose names "stand out in memory and in record," noting that "he could, and possibly should, name every man" if time permitted. "The American railroad man," he concluded, "is without doubt the best in the world, and the "A" company men of the American Army's Military Railway Service were the finest construction and maintenance men the world has ever seen or ever will see."

Conn Cites Danger of Public Ownership

"Fundamentally, the one problem before the United States in rail transportation — in all transportation — is the preservation of the industry in private ownership." This was the initial sentence—and the theme—of Mr. Conn's address on Problems Ahead in Rail Transportation. Stating he is convinced that if "we do not soon consummate policies that will preserve the common-carrier industry in private ownership, there may be *no* private industry left in the United States." Mr. Conn declared that leaders of state socialism are following a definite program "in their attempt to discredit and undermine the principle of private enterprise," and pictured vividly the evils that would result if these efforts are successful.

Mr. Conn then described the present policies and principles of regulation that he feels will lead inevitably to government ownership of the transportation industry, these including conflicting federal statutes and opposing policies of regulation; the policy of the government in promoting direct competition between its capital, which need earn no return, and private capital, which must earn a return; restrictions and prohibitions on the several forms of transportation regarding the owning or operating of other forms of transportation; and the effects of a large volume of transportation business handled by shippers and producers for their own account.

After presenting a series of recommendations for congressional action, designed to correct the situation, Mr. Conn said that, "if private ownership is to prevail, national policies must result in a system of competitive agencies in which the gross revenues of each, derived from the lowest possible basis of individual rates, will leave a net return sufficient to attract private capital on terms no less favorable than those enjoyed by other major industries."

Bentley Describes Safety Program

In explaining how the Chesapeake & Ohio won the Harriman Gold Medal in 1945, Mr. Bentley first discussed the essential qualifications of good supervisors and foremen, particularly those that are necessary if the men under them are to be safe workers, and said that these qualifications are insisted upon by his railroad. Proceeding with an outline of "some of the activities embraced in a good safety program" he mentioned the need for a general safety agent to direct all safety activities, and for supervising safety agents to assist him in the field, describing the functions of the latter in some detail.

Other measures described at constituting elements of the safety program on the C. & O. included the use of safety committees "everywhere" on the railroad; the issuance of a book of safety rules, which was developed when it was found that 95 per cent of injuries was caused by improper acts of employees; employment of the competitive spirit by means of departmental safety contests, including an annual safety conference for the award of trophies; a safety contest set up by the chief engineer and arranged by the supervisors under his jurisdiction; a system for recognizing the efficiency of foremen in preventing accidents among their men; and the issuance of weekly safety bulletins in the maintenance of way department.

Mr. Bentley also discussed the percentage of train accidents caused by defects in or improper maintenance of way and structures, the use of goggles and safety shoes, and the investigation of accidents by committees.

Reviewing the safety record of the maintenance of way, bridge and building and engineering departments of the C. & O., he said that, while in 1945 these departments had 23.5 per cent of the man-hours on the railroad, they suffered only 15 per cent of the injuries.

TREASURER'S REPORT

Cash Balance—September 30, 1945		$ 132.95
Receipts:		
Dues	$1,693.50	
Advertising	170.00	1,863.50
		$1,996.45
DISBURSEMENTS:		
Salaries	$ 572.27	
Social Security Tax	12.37	
Stationery & Printing	687.68	
Postage	58.00	
Rent, Phone, Electric Light	152.30	
Miscellaneous	55.78	
One-Day Annual Meeting at Stevens Hotel, Oct. 17, 1945	3.15	1,541.55
Balance on hand—August 31, 1946		$ 454.90

Signed—C. R. KNOWLES, Treasurer

SECRETARY'S REPORT

Active members, October 1, 1945	450	
New members since Oct. 1, 1945	39	489
Reported deceased since Oct. 1, 1945	15	
Resigned since Oct. 1, 1945	5	20
Total active members, Sept. 15, 1946		469
Associate members, Oct. 1, 1945	29	
New associate members since Oct. 1, 1945	97	
	126	
Total associate members, Sept. 15, 1946		126
Life members, Oct. 1, 1945	79	
Elected to life membership since Oct. 1, 1945	13	
	92	
Reported deceased since Oct. 1, 1945	10	
	82	
Total life members, Sept. 15, 1946		82
Honorary Members		4
Members who served in the Armed Forces 1941-1946, inclusive, and dues waived for duration by action of the Executive Committee		17
Total membership as of September 15, 1946		698

Preventing Bridge, Building and Tunnel Fires

By Herbert I. Benjamin

Vice-Chairman, System Committee on Insurance, Southern Pacific Company

There are many things which supervisory officers can do in the matters of fire prevention and fire control. After the management has approved a plan and appropriated the money for the purchase and installation of fire-fighting equipment, the duty of the supervisor is not only to supervise the installation so that it will do the work for which it was designed, but also—what is more important—to maintain it properly. Fire pumps should be tested periodically to see that they function properly. Hose lines also should be

tested regularly and, after use, should be dried and put away properly. Valves that are to be used in case of a fire should be plainly marked and instructions for their operation should be prominently posted.

Fire extinguishers should be charged at regular intervals, tagged, and occasionally tested to see if they are operative. The matter of where to locate extinguishers should be given careful consideration to the end that they can be found quickly when it becomes necessary to use them.

Foremen and other supervisors have the responsibility of seeing to it that cleanliness and good housekeeping are maintained, because, when a man becomes negligent in his housekeeping habits, fire hazards are created. In bunkhouses, company dwellings, outfit cars, etc., it is the duty of the supervisor to look for and immediately correct unsafe practices. Wet clothes should never be hung around or close to a hot stove. Oily rags should be taken away and burned; hot stoves should not be left unattended; metal protection around stoves should be properly maintained; and flues should be examined and kept safe. Care should be taken when filling lamps to see that they are in good condition and safely located.

Employee Instruction

Supervisors should never take anything for granted, but should ascertain that rules are being followed and that unsafe practices are eliminated at once. It is important that employees be instructed in the proper procedure to follow in case of fire. How many men actually know the location of fire-fighting equipment? How many men know how to use such equipment expeditiously or with the best results?

Cleanliness should prevail when work is done around bridges. Foremen should see that accumulated debris is taken a sufficient distance from the job, so that if it catches fire, the structure will not be endangered. When the work has been completed and final cleanup is made, extreme care should be used to see that all waste material is disposed of or burned at a safe distance from the structure. I have heard of a newly-completed ballast deck structure that was completely destroyed by fire because, when the debris being destroyed was left burning unattended during the night, a change in the direction of the wind blew sparks towards the structure.

Always bear in mind the three important items in eliminating fire losses: (1) do not tolerate conditions that will start a fire; (2) put out a fire in its incipiency—the first three or four minutes are important; and (3) wherever possible, get trained help at once to assist in putting out a fire.

Classes of Fires

The several classes of fires in railroad property, which result not only in physical losses but also in costly losses not measurable in dollars and cents are as follows:

Class 1—*Bridges, trestles, tunnels and snowsheds.* Damage to or destruction of any of these structures interferes with the normal flow of traffic and, therefore, they are more important to railroad operation than other types of facilities. Such structures are frequently in isolated locations, and, therefore, they should be made as fire resistant as possible.

Where it is not possible to give the structure complete immunity to fire, the parts that are subject to ignition should be given some form of protection. A heavy coat of paint with sand applied while the paint is wet has always been considered good protection. However, such a protective coat is not infallible because ties do check, producing openings which may be entered by a cigarette or spark. There are now numerous products on the market which can take the place of paint for covering timber surfaces. One of these, although it is a petroleum product and inflammable while being applied, makes a binder to hold together a heavy coating of pea gravel or rock chips. It has been found that coatings of this type can be applied to creosoted material, providing the latter has weathered enough to leach out the oil. The application of metal checkered plates on wood surfaces and the use of hand rails of steel will also help eliminate fire hazards in key structures.

Ballast-deck structures are afforded protection against fire from the top but if they extend over dry washes, there is always a hazard of fire from underneath. Consequently, all vegetation must be removed from around the bents and the ground scarified before the dry season starts.

Water barrels, each having a bucket hung on the inside, should be placed at specified intervals along a structure and kept filled. Key structures can be given special consideration and protection. If water is available, an automatic or manually-operated sprinkler

system can be installed, which will do much towards eliminating fires.

Tunnels, when wood-lined, should have concrete portals and at least 50 ft. of length concreted at each end so that a brush fire burning on the outside will not ignite the lining. It is important to remove all vegetation from around the portals of such tunnels. Also the replacement of tunnels with open cuts should be considered in cases where the lining has reached the end of its service life.

Snowsheds present another fire-protection problem. When snowsheds are constructed of wood, they should be provided with fire breaks. This can be accomplished by constructing 100-ft. sections of the shed in concrete at intervals, or by constructing wood sections that can be removed or rolled back during the summer season. Definite breaks in the continuity of snowsheds constitute another method of fire protection. Usually, water is readily available where snowsheds are used, and the installation of sprinkler systems, by means of which shed roofs can be sprinkled at least twice a day during the summer months, does not present much of a problem.

Shops and Stores

CLASS 2—*Shops and store buildings.* Neither the B. & B. supervisor nor the roadmaster has very much jurisdiction over this important classification of fire losses. Such facilities are concentrated and values run high. Wood floors in buildings in these areas should be replaced when badly splintered, and holes in platforms should be repaired. Here, also, good housekeeping and the careful disposition of working materials are most important in preventing fires.

Fire-protection equipment in the form of hand extinguishers, strategically placed and regularly maintained, provides first-aid protection against incipient fires in this classification, but the importance of calling the fire department immediately should not be overlooked if there is any question at all as to whether the fire can be put out with a single extinguisher.

While the responsibility of fire fighting in a shop area is mainly that of the mechanical department, the bridge and building supervisor has a definite place in the picture. Usually a B. & B. gang has the function of making building repairs in the area and of seeing that extinguishers are properly charged and placed. The responsibility of having extinguishers in good operation at all times and properly charged should be definitely assigned to one of the departments. It is also necessary that fire hose, connections, etc., are kept in good condition, and firefighting equipment placed in locations readily accessible and properly marked.

The formation of employee fire brigades, equipped with adequate hose carts, fog nozzles, etc., is good practice around shop grounds for handling small fires and keeping the larger ones in check until city equipment arrives. Fire-fighting equipment, such as fog nozzles, motorized fire trucks, O. C. D. pumpers and foam generators, can be secured today that will far exceed the efficiency of old-time methods.

Dwellings

CLASS 3—*Dwellings.* These company-owned structures, furnished for the use of employees, are usually located where no municipal fire department is available, and fire-fighting depends entirely on equipment supplied by the railroad. Here, again, housekeeping is an important item. Stove pipes must be properly installed and cleaned annually, and the woodwork around stoves properly protected by metal shields—all of which is the function of the B. & B. department. It is important that the individual occupying such a house should keep lockers and closets clean, and not keep kindling, wet clothes, etc., too near a stove. Supervisory officers should make inspections at frequent intervals to correct hazardous conditions.

Rolling Stock

CLASS 4—*Rolling Stock.* One of the dangers to be guarded against in this respect is that presented by fires in railroad yards. Where adequate fire lines are not available in yards, steam switch engines should be equipped with fire hose. Also, water tank cars with pumps and fire hose should be stationed in large yards for emergency use.

As a means of protection against oil and gasoline fires resulting from derailments it is important that every relief outfit be provided with fire-fighting equipment. Tank cars, filled with water and provided with pumps, hose, fog nozzles or foam generators, are an added protection for fires of this kind.

An important phase of fire prevention and inspection activities on any railroad is the proper organization of the department to which this work is entrusted. Local fire-prevention inspectors, working in conjunction with shop

fire chiefs, can best handle local conditions. Monthly and annual inspections should be made to correct bad conditions, and to inspect and test fire-fighting apparatus. Reports of such inspections should be made, wherever possible to a central office, preferably headed by a general fire inspector reporting to the general manager or some department head. Correction of many undesirable conditions not requiring large expenditures can be handled quickly under this system.

Fire is one of our worst foes, and fire prevention should go hand in hand with other safety work. A little foresight, care and alertness can do much in cutting down losses. Education of the man who will have to give first aid in putting out a fire is most important.

Federal Interest and Responsibility in Railway Sanitation

By M. C. Hope

Senior Assistant Sanitary Engineer, Land and Air Carrier Section, Sanitary Engineering Division, United States Public Health Service

The Public Health Service has been intimately associated with the problems of railway sanitation for the past 50 years. During that period, the relationships with the carriers have been uniformly excellent. For the purpose of clarifying the present relationships of the service to the problem of railway sanitation, it would be well to consider briefly the historical background behind the present program.

Historical Background

The first Interstate Quarantine Regulations were promulgated in September, 1894, in an effort to control the spread of disease between states. These regulations, while extremely inadequate in the light of present day knowledge of public health, served to standardize to some extent the various protective measures. Strangely enough, the regulations made no provision for the control of the drinking water on interstate carriers. The sporadic occurrence of typhoid fever in passengers and crews on the carriers was indicative of the need for control of water supplies, and the regulations were amended in 1913 to provide for the certification of such supplies by State and local authorities, and the following year definite standards embracing coliform and bacteria counts were adopted.

During this period many states had proceeded with the development of sanitary codes, since the original regulations of the service were concerned only with quarantine measures and procedures. These codes multiplied in number to the point where their inadequacies were readily apparent to all concerned. Various attempts were made to secure some uniformity in codes but they were mainly unsuccessful. The Interstate Quarantine Regulations were revised in 1916 in co-operation with the various state boards of health and resulted in the first comprehensive railway sanitation code. It was quite surprising, however, that the states were unwilling to accept these regulations even though they had a hand in preparing them.

During the period that the railroads were taken over by the government during the first World War, a Committee on Health and Medical Relief was assigned the task of preparing a comprehensive study of railway sanitation which resulted in the development of a proposed code in which the interests of the railroads, the traveling public, and public health were correlated. This code was adopted as a mandatory code for the period of government control of the carriers and was subsequently revised and adopted as the Standard Railway Code by Conference of State and Provincial Health Authorities of North America. The Interstate Quarantine Regulations of 1921 under which we are operating at the present time were revised to correspond in all respects to the Standard Code which was accepted by the individual states and by the American Railway Association.

The past 25 years of railway sanitation have resulted in numerous improvements in the various regulations applicable to railway sanitation. The Joint Committee on Railway Sanitation

was established in 1922 to study the question of water supply on conveyances, and its activities were later broadened to include other aspects of sanitation. The committee is composed of engineering, mechanical, and medical representatives of the railroads, together with representatives from the service. Its report in 1931 is the basis for our present Sanitation Manual, for Land and Air Conveyances Operating in Interstate Traffic, adopted in 1942 and now accepted as the guide for the administration of the carrier sanitation program.

Administrative Aspects of Present Program

At present the Public Health Service is operating under the provisions of Public Law 410 approved July, 1944. This act codified the various laws of the service and also provides that the Surgeon General shall adopt regulations to prevent the spread of disease interstate. These regulations, which are essentially a revision of the Interstate Quarantine Regulations of 1921, are now in the final stages of revision and should be formally adopted and promulgated in the near future. The comments of the Association of American Railroads have been received and certain changes are being made on the basis of their suggestions. The proposed regulations do not represent any drastic departures from present practices and will serve to modernize the program in accordance with present policies.

The magnitude and scope of the problem involved may be visualized by the fact that last year the service issued some 1600 certificates on water supplies and approximately 3800 watering point certificates, of which 1300 water supply and 2100 watering point certificates were issued to the various railroads. Prior to the issuance of such certificates, it is necessary to make a field investigation of the supply and watering point facilities, a tremendous task. The investigations, made for the most part by state health department personnel together with the help and assistance of the district offices of the service, cover all watering points on which requests for certification are received annually from the individual carriers.

Sanitation Manual

The Sanitation Manual for Land and Air Conveyances Operating in Interstate Traffic has been developed with the assistance of the Joint Committee on Railway Sanitation. The present Manual, adopted and promulgated in 1942, is designed to provide public health agencies and carriers with the necessary information on which to base their procedures in the control of water supplies, excreta disposal, garbage and refuse disposal, milk and milk products, eating and drinking establishments, and other items of sanitation.

Of all the items in the Manual, the one which presents the greatest problem is that of the watering facilities. Frankly, present practices in this regard are unsatisfactory. The provisions of the Manual have to a considerable extent been dictated by existing conditions, and the ideal system has not yet been developed. The recently revised hydrant standards list the various types of systems in the order of safety from a public health viewpoint. The ideal system would consist of an overhead system with the hose elevated at all times. The thousands of inspections made of servicing areas revealing hydrants with weepholes and hydrant box drains directly connected to sewer lines, flooded boxes, unprotected hoses lying in the ballast, and unsatisfactory methods of handling watering facilities comprise sufficient justification for the foregoing statements. It is felt that an overhead watering system is practical although considerable study and thought must be given to the problem in order to develop such a system.

The use of weepholes for frost protection of hydrants has created definite health hazards in the protection of the water supply. It would be desirable to eliminate them completely and provide frost protection by some other means such as heat as has been done in a number of installations recently. Where weepholes are used, the present standards provide for an entirely separate drain line in order to minimize the possibility of contamination. The flush type hydrants are the least acceptable from a public health viewpoint and then only if certain features relative to location and drainage are observed.

One of the weakest links in the chain of supplying water to conveyances is the water hose. The human element is so intimately involved in the question of handling water hose that it is not surprising to note frequent violations of the sanitary principles involved. In many cases the personnel engaged in watering operations are not of the highest caliber and also have no real conception of the problem involved. Since it is impossible to establish stand-

ards which will eliminate the human element in this regard, it is apparent that either closer supervision be exercised over present personnel or that a higher caliber of personnel be employed.

Other Essential Facilities

In addition to the watering facilities, every servicing area where drinking water and foods are handled should be properly equipped with essential servicing facilities to expedite the performance of the carrier's operation in an economic, safe, and sanitary manner. Desirable sanitary facilities should include platforms and gutters, with yard drainage system; facilities for handling ice; soil cans with proper storage and cleaning equipment; garbage cans with cleaning facilities; incinerator in the larger yards; and employee conveniences such as lockers, washrooms, and toilets. Housekeeping is one of the major problems in any servicing area. Covered rat-proof metal garbage cans should be used and the contents disposed of daily. Such cans should be stored in a separate closed room having a concrete floor and can-washing facilities.

There is the perennial question of excreta disposal at terminals and yards. Numerous inspections in such areas have shown that wastes from toilet hoppers are being discharged to the surface of the ground. This practice constitutes a serious menace to the watering facilities. The standard methods of handling this problem have been either to lock toilet room doors while in servicing areas or to attach soil cans to the toilet-hopper outlets. Unfortunately, both methods involve the human element. Both methods of control must be considered as temporary expedients. The various health authorities in this country are extremely interested in a study of the problem of excreta disposal on railway conveyances which has recently been initiated. The cost, estimated at $200,000, is being borne by the Association of American Railroads, and the studies are being conducted under the direction of Dr. Abel Wolman, professor of sanitary engineering at Johns Hopkins University.

The certification issued on watering points is based on both the water supply and the watering point facilities. The lower of the two certifications presents the overall status of the point. Three types of certification, approved, provisionally approved, and prohibited, are issued. A provisional certification indicates that the watering point is not entirely satisfactory although the defects are not sufficiently serious to warrant a prohibited certification. All provisional certifications issued have a specific time limit. In the event the necessary corrections are not made within the allowable time, a prohibited certification would be issued.

What About Our Railroad Stations?

J. C. Sherrick

Partner, Holabird & Root, Architects

Most of our railway stations are of another era—an era when the supremacy of the railroads was unchallenged. Then, the traveler had no choice and was compelled to go to the station for his transportation needs. The large railway stations of the past era were designed to enthrone the machine and impress the traveler. The traveler, duly impressed, was expected to endure some inconvenience and discomfort. The small stations of that era, built to a style attempting neither magnificence or comfort, were designed as humble servants of the machine to load passengers into trains with as little damage as possible.

Station Must Be Inviting

In the present new and competitive era of transportation the traveler, having other choices of transport, is not compelled to visit the railway station. The station must be made so inviting that he will be happy to enter it or else he will, with increasing frequency, choose some other way of travel. To be thus inviting, the new station must be designed not with the view to awe or impress the traveler, but to serve him. When entering the station, the traveler must be made to feel he has nothing further to worry about. From this point to his destination his

way should be made easy and pleasant, and it is to modern architectural design, aided by modern methods and materials, that we must look to accomplish this highly desirable result.

Good architectural design will assure well-planned and easy circulation of patrons from the street to trains. The way must be made unmistakably apparent and necessitate minimum effort in buying tickets, securing information, or checking baggage. Where signs must be used as an aid to circulation, they should be designed to reassure the patron instantly as to his proper route, and should be so placed and worded as to make him feel that he is the guest of the railroad.

Also, good architectural design will aid considerably in making the somewhat annoying process of buying tickets more pleasant. Where tickets are purchased the railroad can demonstrate its concern for the travelers' welfare by providing features that will create an atmosphere of friendly interest and reassuringly efficient service. The grilled hole-in-the-wall ticket window should disappear from most stations and be replaced by an open counter. Perhaps the design can be so arranged that the railroad can relieve the traveler of his handbag at this point and deliver it to him at the train by means of conveyor systems.

Interesting Waiting Areas

The facilities for passengers waiting for trains must be so planned that the time spent in them will be a pleasant introduction to a delightful journey. The lighting should be planned to be an integral and important part of the architecture and must be adequate for those who care to read. The chairs must be comfortable and inviting and arranged to accommodate passengers both singly and in groups. There is an opportunity for planned and lively exhibits showing the advances made in railroading, to stimulate the passenger's interest, similar to the air lines' outstanding use of beautiful, illuminated maps as decorations and educational exhibits. The possibilities in the use of the radio, motion pictures, television, and recorded music should not be overlooked in plans to make the waiting period interesting to the traveler.

Design Embraces All Features

Refreshment places should be conveniently located but their importance as a source of revenue should not be allowed to make them discordantly conspicuous. News-stands, too, must be planned with the architectural design so that the opportunity to examine their offerings is all a part of a pleasant experience of waiting for a train. Space for the care of infants and small children has almost become a necessity in many stations, and is now provided in those of a number of larger cities.

A properly designed and well-conducted railroad station dining room can be a great deal more than an incidental service to the traveling public. Such a dining room can attract customers from among the non-traveling residents of a city, and such traffic offers an opportunity to publicize the pleasures of modern railway travel.

All of these results will be achieved not only by careful planning and arrangement, but also by the wise selection of available construction methods and materials. It is to be expected that the basic structural materials—concrete, steel, brick, stone, and wood—will be used for many years to come. However, it is in equipment and accessories that great improvements have been made and further advances are to be expected.

Air Conditioning and Heating

Air conditioning for railroad stations is surely desirable if our new stations are to match our new trains in comfort. But the feasibility of air conditioning large stations has been made uncertain by peculiar difficulties. These arise from the vast size of the spaces and from the rapid and wide variations in the density of the crowds at stations. But new developments give some promise for the solution of the problem. New air-handling systems carry air through ducts at velocities of 4400 ft. per min., which is more than four times the velocity formerly considered the maximum. These developments mean that duct systems can be smaller and simpler, and outlets farther removed from the areas served. Work is being done on refinements in control systems.

Panel, or radiant heating, is not precisely a new system because it was used by the Romans. The huge waiting room of the Cincinnati Union Terminal, planned by Felheimer and Wagner, architects, is warmed by an application of the principle of panel heating. The roof and extensive glass areas of this room are double and warm air is circulated within the double construction, maintaining a comfortable temperature in this vast room

without a single radiator. Panel heating provides comfort at comparatively low air temperatures and is worth considering when selecting a heating system for stations or service buildings.

In lighting, we are all much interested in the development of the gaseous tube, which is especially well adapted for incorporation as an integral part of architectural effects. Its low current consumption, low heat output and long life are also advantages not to be overlooked.

Double and multiple glazing, long used in the construction of railway cars, is available in several convenient forms of units. When combined with improved heat-resisting glass, it is a valuable aid in relieving the heat load in air-conditioned spaces and in maintaining comfort in other spaces.

These are but a few of the more familiar and proved systems and materials. These and many other developments, as they become available and prove themselves worthy, will be incorporated in new railway buildings, but it is only through the artistry of modern architecture that they will become integrated in the design to give expression to the new spirit with which the railroads must meet the new era.

Every architectural style has been modern in its day and has accurately reflected the spirit of its age. Since the spirit of today is an inquiring one, which is exploring new forms of energy, questioning established traditions, seeking new forms of social organization, and discarding old forms of trains for new and exciting designs, modern architecture will also explore and develop new and exciting ideas for passenger stations, so that the traveler of today, or certainly of an early tomorrow, will consciously, or instinctively, appreciate and approve those ideas as a true expression of his own spirit.

Adapting Turntables to Meet Modern Conditions

Report of Committee

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MANY railroads today are finding it necessary for their turntables to accommodate heavier locomotives with longer wheel bases than those for which the turntables were originally designed. The longer wheel bases make it difficult in some cases to balance the load properly, thus adversely affecting the operation of the tables. The transfer of many former main-line locomotives to branch lines and the use of still larger ones on main lines has severely taxed many tables that were not designed for the loads now imposed on them, throwing excessive loads on the steel structure, the centers and the circle.

The two prevalent types of turntables are the balanced and three-point types. The balanced-type table will handle locomotives advantageously only when the locomotive can be balanced on the table. The increased use of Diesel locomotives and similarly-constructed types, in which the wheels are spaced far apart, has increased the problem of operating and maintaining balanced-type tables. Often in moving such a locomotive onto the table, the lead trucks pass the center support before the trailing trucks reach the table, thus causing the approach end to rise and allow the trailing wheels to strike the ends of the rails. This tends to drive the rails toward the other end of the table, and also causes a thrust against the turntable center, which increases maintenance costs and the possibilities of failure. In some cases it is impossible to balance locomotives properly on

balanced-type tables due to the distribution of locomotive weight and wheel spacing. Where this is the case, the only positive remedy is to convert the table to the three-point bearing type.

Balanced-type tables up to 120 feet in length are in use. Three-point type tables range in length up to 135 feet. The length of the turntable should be somewhat greater than the longest locomotive which it will be required to handle to allow some room for adjustment of the position of the locomotive to distribute the load properly, keeping in mind that no part of the locomotive should project beyond the end of the table. Where dead locomotives are handled across a turntable by switch engines, the table should be long enough to accommodate the full length of both engines without the necessity of detaching the tenders.

Turntable Decks

The decks of all turntables should be made tight enough to keep dirt and other debris from the steel and trucks, and of sufficient strength to support the loads properly. One railroad recommends a solid timber deck built along the following lines:

"Decks on turntables should be constructed of treated timbers, at least 8 in. thick, laid tightly together to protect the main girders, floorbeams, and end trucks from dirt and cinders; also from rainfall and the drippings from locomotives, with drain holes provided at suitable locations. Manholes should be provided in this solid-type deck to afford access to the center and end wheel bearings. These holes should be covered with removable steel plates. Suitable treated timber shims are to be placed between the bottoms of the deck ties and the top flanges of the main girders. The top flanges of the main girders, cross girders and floorbeams should be protected by a non-corrosive sheet metal inserted above or below the timber shims. These strips should be from 6 to 10 in. wider than the top flange cover plates and the excess width should be bent downward on each side to provide full protection to the steel.

"At each end of the table, where the wheel impacts are highest, an H-beam or steel end tie should be provided. At important terminals, where tables are in constant use, three H-beams or steel end ties should be provided at each end. To minimize the effects of derailments on turntables, guard rails 4 feet long, and of the same weight as the deck rails, should be installed at each end and provided with foot guard blocks and other necessary fittings. The positions of the deck rails should be secured by means of four long strap rail anchors, each anchor to consist of a steel bar, approximately 2 in. wide by ¾ in. thick by 8 feet 6 in. long, bolted rigidly to the web of the deck rail and to the deck timbers.

"Deck-girder tables should be provided with timber handrails and posts. Truss spans may be provided with cable handrails, fastened to the end posts, center posts, and hip verticals by means of cable clips."

The solid timber deck is considered excellent. If the protection which it is designed to provide is not sufficiently urgent to justify the expense of such protection, the ties can be spaced on wider centers and covered with shiplap or tongue-and-groove decking to keep dirt from sifting through the dock.

Rail locks of a positive type are essential in the operation of turntables. For balanced tables with considerable vertical movement at the ends, a sliding tongue on the table may engage a U-shaped forging on the pit wall. On three-point-bearing tables, where the ends do not change elevation, holding may be done by a member sliding from the table rails and engaging the approach rails in the web just under the head, thus eliminating the expense of additional parts and assuring correct alinement between the rail ends. These engaging members should be provided at both ends of the table if the rails do not line up from one side of the table to the other.

Each locking member can be controlled from levers adjacent to, but not inside, the operator's cab. It has been found that turntable operators sometimes use the locking device to stop the table, which places an unnecessary strain on both the table and radial track rails. By placing the rail lock levers outside the cab, this tendency can be controlled. To operate the lock at the far end of the table, a smaller diameter pipe line, supported on brackets at the side of the table, may be used. Where shafts are used in connection with levers at the ends of the table, antifriction bearings should be employed and all surfaces should be kept well oiled so that the locking mechanism will operate with minimum effort. If found desirable, limit switches may be incorporated in the design, making it impossible to apply power except when the lock is disengaged. Also included may be signal lights at the ends of the table, which indicate red at all times, until

the lock is engaged, when they will change to green.

Types of Drives

The power mediums for turning tables are electricity, air and gasoline motors, the first named being the most satisfactory where electric power is available. Air motors are sometimes used on unimportant tables or as emergency power on important electric-powered tables. Air motors may be operated entirely independent of outside power sources by taking the air from the locomotive being turned.

Balanced-type tables may be turned satisfactorily by a tractor connected to one end of the table, unless the locomotives are of such weight or length as to cause an unbalanced load and severe friction on the truck wheels at either or both ends. In such case, it is necessary to counterweight the tractor or to add a second tractor to the opposite end. Care should be taken to maintain the wheel bearings to the highest degree of workability.

Three-point-bearing tables are commonly powered by two electric motors at diagonally opposite corners of the table, each geared to a drive wheel and integral with the trucks. The design should be such that both driving wheels will bear on the circle rail, irrespective of the position of the locomotive on the table. The motors should be of sufficient capacity so that, in case of failure of one motor, the other will handle the table satisfactorily without undue overheating. A duplex reversing and variable speed drum controller should be used to control either or both motors. Grid resistors of cast iron or edge-wound steel should be employed, together with an overload and low-voltage panel. These necessary items many be arranged in one cabinet fully wired, thus reducing the time out of service for installation.

The current collector at the center of the table should be placed overhead on an arch of standard clearance, and should be of sufficiently heavy construction to eliminate back-guying. This arch should be supplied with a ladder and inspection platform. The collector housing should be rugged and as nearly water and smoke-proof as possible.

Turntable brakes should be maintained at a high state of efficiency. This should lessen any tendency on the part of the operator to plug or reverse the motor to stop. Electric brakes are procurable in thruster, magnetic or solenoid types. Also, hydraulic and mechanical brakes are used extensively. The last named type gives the best performance generally, as it is less affected by shocks and vibration and is simpler to maintain.

Speed at the end of the table should be 150 to 200 feet per min. A faster rate will often cause passing of the spotting point, requiring reversing and unnecessary operations.

Circle Rails

Circle rails of 90-lb. or 100-lb. rail are recommended for balanced-type tables, and 131-lb. rail or 175-lb. crane rail for three-point support tables. A firm support in the track area only is generally sufficient for the circle rail of a balanced-type table. Timber bulkheads on piling or on suitable bearing material are sufficient at locations where tables are used infrequently. Wood ties embedded in masonry, supported on piling or on other firm support, are recommended at important engine terminals. For three-point-support tables, a full circle wall of masonry construction, supported on piling or other firm support, is imperative to insure reliable service and to avoid high maintenance costs. The circle rail should be placed on steel plates rather than directly on the wood ties.

For balanced-type tables, when wood ties are used, standard tie plates, track spikes and rail fastenings afford suitable anchorage. For three-point-support type tables, the anchorage offered must hold the circle rail to true surface and alinement at all times. Unless positive anchorage is afforded, the heavy loads on the circle rail and anchorage, together with corrosion and wear of the bearing plates, clips, wedges, clamps, and anchor bolts will result in the circle rail getting out of line and surface. Adjustments are difficult and are often delayed, especially at important terminals, until the situation becomes critical. The importance of keeping the circle rail fastenings tight cannot be over-emphasized as most of the trouble experienced with circle rails can be traced to lack of proper maintenance of these fastenings.

To avoid high maintenance costs, the circle-rail support should be proportioned to the frequency of use and class of power turned, with anchorage that is positive, yet readily adjustable. Bearing plates should be of sufficient size and spaced close enough together to prevent excessive maintenance.

Welded joints for circle rails of sections 100-lb. and heavier are feasible

and have certain advantages over bolted joints. The welded joint does not require a different type of support than at other points of the circle rail, whereas bolted joints do, and creeping of the rail from the established points of joint support is, therefore, not significant. Line and surface of the welded joint is less troublesome to maintain than the bolted joint, because the tendency of the bolted joint to straighten and cant outward is overcome in the welded joint.

The replacement of broken and damaged rails, in the event of an accident, however, is simpler if the joints are bolted, unless welders and welding equipment are immediately available at all times at the turntable.

Radial Tracks

At most turntables, there is a definite movement toward the circle wall of the radial and lead track rails. When the rails move to such an extent that they foul the table rails, the line of least resistance is usually followed, of cutting off the ends of the rails, which may have been end hardened. To prevent this movement of the radial or lead rails, or to reduce it to a minimum, it is recommended that all radial and lead tracks be properly maintained with a full ballast section and that the rails be anchored according to main-line practices or standards. The rails of radial and lead tracks may be fastened to the rim girder or circle wall by the installation of 100-per cent angle bars, with the bases of the bars fitting snugly against the outside of the rim girder or wall, or by the installation of rail anchor bars securely bolted to the webs of the rails and adequately fastened to at least six ties.

Good surface of the radial tracks is necessary to prevent excessive strain on the fastenings at the circle wall. Often the track ties immediately behind the circle wall cannot be tamped properly, resulting in surface bending of the rail. In such cases a concrete mat or a grouted ballast section is recommended to support the radial tracks. This type of support has proved satisfactory and has reduced much trouble with radial tracks.

The steel and bearing details at the ends of the table span, as well as the tracks supported on the coping timbers or circle wall, are subject to repeated impact shocks and frequent hammering by locomotive and tank wheels when coming on or leaving the table, resulting in fatigue failures, as well as damage to the end wheel bearings. To reduce these shocks, shock-absorbing material, consisting of vulcanized layers of cotton duck and rubber compound, has been used. This material can be placed between the bottom of the rail or rail plates and the tops of steel ties or bearing plates at the ends of the table, and on the circle wall. It must be fixed securely in position, preferably by means of plates or ribs, acting as shoulders, welded to the steel ties or bearing plate.

Shock absorbing materials have also been used with satisfactory results by several roads at other points of contact where shock and impact are severe but experience with this method of reducing shock is not sufficiently widespread to permit definite conclusions to be drawn.

Conversion Details

The conversion of balanced to three-point-type tables may be accomplished by the use of two heavy electric tractors at diagonal corners of the tables and the application of roller-bearing wheel assemblies at the ends. However, a preferable method is to install new end trucks with electric drives, integral with and geared to two wheels at diagonal corners, wherein a large part of the load is utilized for traction. Truck frames should be of heavy section to withstand excessive impact, and the wheels should be forged steel with hardened treads. The treads should be flat and up to 6 in. wide to secure full bearing under slight eccentricities in the radius of the circle rail. The wheels should be of as large diameter as is consistent with the general design and space available. With the use of driving trucks, an operator's cab to house the duplex control will be mounted on brackets at the side of the table at one end. Convenience and safety require that the cab be placed at the end of the table at a distance approximately 6 feet from the circle wall. Wood construction with heavy canvas back roofing is generally preferable.

Converted tables may be considered as two spans, with a proportionate reduction in the load on the center and the table girders. Most all girder tables can be converted without reinforcing, and may also be extended, if necessary, to accommodate longer locomotives. Existing turntable centers, if in good condition, may be continued in use. These may be of the bronze disc or roller type without noticeable difference in friction. The latter, being lubricated with grease, should be filled to the top

to prevent the entrance of water and dirt. Where oil is used to lubricate disc centers, the centers should be well sealed so that a film is maintained over all wearing surfaces.

Two or Four Wheels

The general practice in the past has been to use four wheels at each end of turntables. However, installations have been made occasionally with only a single two-wheel rigid truck at each end of the table, not only in the case of light balanced tables, but, recently, for a 120-foot three-point-bearing type, heavy-duty table, which is reported to be giving satisfactory performance.

Considering only the table proper, the initial cost of the two-wheel installation will be less than for the four-wheel installation, and to a greater degree where the wheels are equipped with large capacity roller bearings. On the other hand, the wear on the circle rail and wheel treads will be much greater for the two-wheel installation than for the four-wheel installation. To give an idea of how loads affect wear, we can draw on the experience of the roller bearing manufacturers, who have found that the useful life of a roller bearing varies inversely as the cube of the load. This rule, if applicable to all types of rolling contacts, would indicate that the circle rail, wheel treads and roller bearings, would wear out eight times faster for the two-wheel installation than for the four-wheel installation, assuming the same size rails, wheels and bearings for both types of installation. It is sound reasoning to expect this theory to apply and to conclude that four-wheel ends are more desirable than two-wheel ends. Accordingly, the four-wheel ends are recommended when the difference in cost of installation is not too great to make them uneconomical. Any feature which reduces friction and loading on any moving part of a turntable is definitely desirable.

The turntable circle wall should be built of concrete, designed and maintained to provide proper strength. The turntable pit should be paved with reinforced concrete, 6 in. thick, with adequate expansion joints. The surface of the pit should be constructed with proper slopes and valleys to provide for quick drainage. In all cases, a study should be made of local drainage conditions at the turntable so that proper catch basins, sumps, and drainage systems can be installed. It is considered good practice to provide headroom of 12 in., or more between low steel of span and the top of the concrete paving for snow clearance.

As it is frequently necessary to jack up a turntable span for repairs or inspection, four concrete jacking pits should be constructed when the pit concrete is being poured. A height of 30 in. is necessary between the bottom of the steel span and the floors of the jack pits to provide headroom for the average jack, with a wood shim above and below the jack. The inspection pit, or bay, in the circle wall should be of adequate size to allow two mechanics with necessary tools to work, and should be located in line with the jacking blocks.

A serious difficulty experienced with some much-used and heavily loaded turntables has been the tendency of the truck wheels to travel in a tangent off the circle rail, and subsequently to jump back to line with a snapping action. This produces a severe strain and shock on the entire truck system and on the circle rail and fastenings. This can be controlled to some extent by the installation of rods, or bars, with turnbuckles, from the ends of the truck frames to the girders. A large turntable manufacturer has adopted the standard practice of tilting the truck wheels slightly toward the center of the table, so that the axles produced intersect on the vertical axis of the center pivot in the horizontal plane of the top of the circle rail. This method permits coning of the wheels. Unless the truck is tilted, the coning of the wheels increases the tendency of the wheel to travel in a tangent off the circle rail.

The inspection of turntables at regular intervals by representatives of all maintaining departments is necessary, and responsibility must be definitely established as to maintenance, including lubrication, cleaning, keeping circle rail properly adjusted, and all other necessary operations. It is considered good practice to maintain a suitable stock of replacement parts for emergency use, such as spare trucks, at least a portion of the circle rail, bearings and other items.

In conclusion, it can be said that modern conditions are placing greater responsibilities upon the maintenance officer, and are drawing more and more upon his ingenuity to adapt existing turntables to meet the needs of the future. New tables, ideally designed to suit immediate needs, are not often readily obtained, and, from an engineering standpoint, it is not good prac-

tice always to solve problems of inadequacy in old facilities by replacing them with new facilities. Rather, wherever possible, it is the duty of railway officers to make old facilities meet the new requirements. This is being accomplished in the case of turntables by the conversion of balanced-type tables to three-point type tables, by lengthening tables too short for requirements, and by strengthening others, as well as the replacement of generally obsolete features with improved parts.

DISCUSSION

H. M. Church (C.&O.) stressed the importance of using solid timber decks on turntables. H. T. Livingston (C.R.I. &P.) said that on his road wedge-shaped timber members are placed between the ties over the girders to protect the metal surfaces from corrosion. Stating that turntables are machines and not bridges, he urged that the mechanical forces be given instructions for oiling and cleaning them and for the proper operation of locomotives over them, the latter to include a prohibition against opening locomotive pet cocks over turntables. In maintaining a suitable stock of spare parts, he cautioned that trucks and motors, being expensive, should not be stored at all points where turntables exist, but only at a central point on the system. He questioned the use of cabs for turntable operators, reasoning that better vision can be had without them. If cabs are provided, he said, they should be placed at the centers of the tables.

Methods of Improving Strength, Durability and Wear Resistance of Concrete

Report of Committee

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THE railroads, public utilities and governmental agencies are now having to spend large sums of money to repair concrete masonry that was originally thought to be practically indestructible. One major railroad estimates that it has spent $3,000,000 during the past five years to repair or replace disintegrated concrete, and that an expenditure of an additional $1,000,000 will be required for similar work within the next five years. Another railroad, with less mileage, estimates that $200,000 will be required to be spent in the next five years. One railroad has already spent $300,000 to repair its concrete grade separation structures in one city alone. Several roads estimate they will have to spend around $100,000 a year on concrete repair work until such time as their necessary repairs catch up with disintegration.

The concrete enthusiast may think that all of the defective concrete referred to was placed before the water-cement ratio gained prominence. Such is not the case. One railroad reports that the present bid price for replacing defective concrete in 35 bridge structures, built between the years 1928 and 1930, is $100,000. The concrete for these structures was designed for 2,500 to 3,000-lb. concrete in accordance with the water-cement ratio theory in effect at that time, using well-graded aggregates and designed and placed under close supervision. Test cylinders showed strengths equal to or in excess of the designed strength. Abutments and walls were waterproofed on the back

side and were backfilled with crushed stone drained by vertical and horizontal drains. The sad part of it is that no one has been able to determine the exact cause or causes of this disintegration.

Attention is called to the fact that several monumental concrete dams built within the last few years are already showing serious disintegration. The Parker dam, for example, was completed in 1938 by the U. S. Bureau of Reclamation at a cost of $6,000,000. Within 2 years' time it was found to be seriously disintegrated and experts do not yet agree as to the exact cause.

Most of the members of this Committee are construction men who have been in charge of placing concrete for a long time, and who have also had to remove or patch considerable concrete. None of us claim to be concrete experts. The average construction man has little, if any, time for research or investigation. You might say he is "on the firing line." He takes the plans, specifications and materials furnished him and develops them into a finished product to the best of his ability and at the least possible cost. We are perturbed about the lack of durability of concrete, and we claim that we have a right to be perturbed when some of us see concrete we placed with pit-run, unwashed gravel, having say 60 percent sand and 40 percent pebbles mixed and placed by rule of thumb by unskilled men in unfavorable locations, outlast concrete placed more recently under present-day rigid specifications.

Inherent Weakness

The inherent weakness of concrete as a building material, aside from the fact that one or more of the materials used in its manufacture may be defective, is that it involves innumerable opportunities for something to go wrong or for someone to do something wrong before it is actually mixed, poured, cured and ready for use. One mistake or omission may be all that is required to impair seriously the strength and durability of the finished product.

For instance, let us assume that a rush contract building job is under way. The specifications for the concrete are A-1; the cement and concrete materials delivered to the job are the best that could be desired; and we believe that everything is in readiness to pour a 100 percent perfect concrete floor. The concrete finishers then arrive on the scene and demand that the concrete be delivered with an excess of water, otherwise they will walk off the job. They expect to get the overtime pay while waiting for the concrete to dry out, or else.

Put yourself in the inspector's shoes and decide what kind of a floor that building owner is going to get. You say "that cannot happen here," but it has happened here. Until such time as the owner, who foots the bills for concrete maintenance work, and all of us who design and build concrete structures, wake up to the fact that durability of concrete is more important than the strength of concrete, the reputation of concrete as a durable building material will remain in danger.

As long as strength was considered the desirable feature to be obtained in concrete and we learned that the desired strength could be obtained by controlling the water-cement ratio, everything was rosy for the architect, the engineer, the cement manufacturer, the aggregate supplier and the contractor. We had something we could see and get our teeth into. We made 7-day and 28-day cylinders, crushed the cylinders, found that the correct strength was there, and everything was fine. We were all "authorities" on concrete. Now, 15 years later when this same concrete is showing serious disintegration and sizeable expenditures are required for repairs, the maintenance engineer finds these former "concrete experts" rather hazy in their recollections as to exactly how concrete of such inferior qualities was made.

Many Disillusioned

For several years many of us have been disillusioned with the water-cement ratio theory. We labored under the general opinion that too much water was the sole cause of all poor concrete. When inspecting any disintegrated structure built before this theory came into effect, we have taken one look at the structure and shook our heads knowingly with the remark, "too much water—it's a wonder it has stood up this long," and walked off. Now we may have to inspect a disintegrated structure on which we designed the mix ourselves in accordance with the water-cement ratio theory, using what we thought were A-1 aggregates, properly proportioned, and on which we know the test cylinders were satisfactory. This is an embarrassing moment, and probably the time when we must admit, at least to ourselves, that we are not experts on concrete.

Possibly the early users of steel had about the same trouble with that mate-

rial that we are now having with concrete. Steel is now made under the direction of expert technicians, with close control from the raw material to the finished product. The field and laboratory control of concrete should be under experienced men comparable with those of the steel industry. In addition to a "definite strength" concrete, we believe that specifications should call for a "definite life" concrete, say a 3,000-lb., 35-year life concrete, or whatever strength and life is desired, with the reasonable certainty that the cement and aggregates, if mixed, placed and cured properly under expert supervision, in accordance with the specifications, will give that strength and life. Every laboratory testing concrete materials should have specialized technicians who, after making the necessary tests on the cement and aggregate, and knowing the conditions under which the concrete is to be used, can estimate closely the life of the concrete to result from the materials tested. The one who furnishes the money for the construction is entitled to know what life concrete he is going to get. Perhaps 20-year concrete is all he wants. However, if he wants 50-year concrete, he should know that he is going to get it, and what it will cost.

It is not uncommon practice to specify that the inspection of the concrete materials as well as of the mixing and placing on the job, be taken care of by an approved laboratory at the expense of the contractor, and that the cost of this inspection be included in the contractor's bid price for the concrete. Under such a set-up, the laboratory is faced with the possibility that if it rejects any materials or workmanship, it stands the chance of not being employed on further work by the contractor. In some instances, when the railroad's field staff is inadequate, a railroad contractor will carry the concrete inspector on his own payroll. In such cases, those in responsible charge are evidently reluctant to forego all concrete inspection and, at the same time, are desirous of burying the cost of such inspection. In such cases, the owner still pays the full price, but stands a poor chance of obtaining good inspection.

Unless the concrete materials to be used have already proved their durability in actual use, or the railroad, or the owner, carries a competent staff of concrete technicians to do the work, all concrete materials and mixing and placing should be in the hands of a competent laboratory, experienced in concrete work, and employed by and directly responsible to only the railroad or the owner. And here again, we say that the laboratory should be both competent and willing to deliver concrete of the life the railroad or the owner specifies. We believe that by now these laboratories are fully cognizant of the fact that the ills of concrete are many, but we insist that laboratory personnel, or, for that matter, any of us do not regard our responsibilities less seriously by reason of the fact that even poor concrete will last 15 or 20 years, when we will be on other work.

Much of the information contained in this report was obtained through a questionnaire sent to railroad men and representatives of other organizations, all of whom are well experienced in concrete manufacture. Replies were generous and the committee is appreciative of the assistance given.

This report covers only concrete that is exposed to weathering, freezing and thawing. Little will be said about strength, as we consider that the water-cement ratio theory and grading requirements that have been in effect for several years—with which you are all familiar—definitely control the strength of concrete. We are most concerned with durability, without which strength and wear resistance are unimportant. Many of us would gladly trade 1,000 pounds per square inch in our concrete strength for another 10 years of durability.

Many railroads have their own concrete specifications, and those who do not, use A. R. E. A., Portland Cement Association, or American Concrete Institute specifications, all of which are very good. One railroad prefers the National Crushed Stone Association's Bulletin No. 11 for proportioning. We will not discuss details of mixing, placing, etc., which are already covered in the specifications you use, and with which you are all familiar.

What Should Life Be?

In our questionnaire we asked, "In your opinion, what should be the life of a well-designed, well-placed and well-cured concrete, exposed continuously to weather in the northern part of the United States, using 5½ gal. of pure water per bag of cement, with a good grade of hard, crushed granite or trap rock for coarse aggregate and pure silica sand, with adequate fines, for fine aggregate, using Type-I Cement meeting present-day specifications?" Typical replies read, "No limit—better with

age"; "80 years upward"; "60 years"; "50 years or more"; "indefinite"; "a lifetime."

To a question as to how one would alter or improve the above concrete to obtain longer life, the general opinion was that this concrete could be improved by being properly drained, and the exposed surfaces waterproofed against seepage water. This would give a concrete made from durable, inactive, non-laminated, non-absorbing aggregates, well drained and waterproofed against moisture. If the aggregates available to you in your territory approach the above in durability and non-absorption, and your workmanship is good, you are indeed fortunate, and you should have no serious trouble with your concrete.

To some, this might seem to be the answer to the complex question of how to obtain durable concrete. The quality of the aggregates used certainly do play an important part in obtaining sound concrete.

Comments on Aggregates

In preparing this report, it was interesting to note the comments relating to aggregates. One state department reported that it has used trap rock extensively and has had no serious trouble with concrete disintegration. Another report on a 35-year pavement, without disintegration, in which quartzite was the coarse aggregate. Trap rock is not subject to laminations, is tough and non-absorbing. It has an absorption of 0.34 percent in 3 hours as against 1.19 percent to 1.62 percent for limestone, 1.17 percent for gravel, and 2.54 percent for slag. However, most of us believe that just as satisfactory concrete can be made from other aggregates if the proper precautions are taken to obtain sound materials. This is fortunate, as we are, of course, obliged to use the highest quality of materials that are economically available, the quality to be judged by close observation and tests of the component parts, as well as the finished product.

Laboratory Tests

Accelerated laboratory tests of concrete and concrete materials that will duplicate actual field conditions, have not yet been developed. When we consider that one of the main constituents of cement starts to hydrate immediately and completes hydration in about 28 days, while another equally important one does not start hydration for several days and continues hydration as long as water is present, we have some idea of the difficulties of laboratory tests duplicating field conditions. In the case of the Parker dam, it was found that at the time the outer shell was shrinking with progressive drying, the interior concrete, where the residual mixing water was still available, was swelling.

Cement

When the ingredients of portland cement are burned at a high temperature and then cooled, they combine and form tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra-calcium alumine ferrite, with small amounts of calcium sulfate, magnesium oxide and alkalies. The combining of these compounds is largely affected by the time and temperature of burning and the rate of cooling.

In the mixing of cement and aggregates to make concrete, the hydration of tricalcium silicate starts immediately, is about complete in 28 days, and is responsible for early strength, accompanied by considerable heat. The dicalcium silicate does not start to hydrate until several days after mixing and continues hydration indefinitely in the presence of water. Tricalcium aluminate is responsible for early strength, generates high heat, is responsible for excess expansion, is most affected by aggressive water, and is responsible for several of the undesirable qualities of cement.

We know that cements are not alike, although they meet a certain definite specification. To the construction man, the standard A. S. T. M. specification for chemical requirements for Type-I cement, which is the type most universally used, is conspicuous by its failure to place any limit on but 4 of a possible 11 limitations. To this man, it would seem that almost anyone could make Type-I cement, although plant chemists assure us that such is not the case. Be it as it may, it seems to us that the chemical requirements for Type-I cement should be more comprehensive, as Type I is the cement most universally used.

A. S. T. M. Type-II cement is more closely controlled than Type I. It is lower in tricalcium aluminate, which results in reduced heat, with less volume change and greater resistance to alkali water. This type cement is used extensively on Bureau of Reclamation work in place of Type I, and we believe it deserves your consideration for future work, particularly for massive

sections, where considerable heat will be generated.

Type-III high-early-strength cement is used on emergency work where early high strength must be obtained. Its high content of tricalcium aluminate, required for early strength, is not conducive to durability.

Type-IV low-heat-cement and Type-V sulphate-resisting cements are special cements to meet special field conditions, as indicated by their designated names.

Keep Cement to Minimum

The cement content of concrete should be kept to a practical minimum. It is the most unstable of the concrete materials. It generates heat with accompanying contraction and expansion, changes in volume with moisture, and is subject to action by active water. Also, if the cement contains excessive free lime or alkali, any cement over and above the minimum required means that the resulting concrete will contain more of these undesirable substances. Surely there is no good reason for an excess of cement, although this is one of the most common abuses of the material. We frequently use a little more cement than we think is actually required, just to play safe.

Starting about 1940, a lot has been said about the disintegrating reaction between cements high in alkali and certain aggregate in the Northwest. The excess alkali in cement is considered as a rover that has not become fixed by being incorporated in the cement, and reacts destructively with some type aggregates. The finer the cement, the easier the alkali is released. Opaline silica is the one constituent of aggregates which, practically all agree, reacts unfavorably with high-alkali cement. A well illustrated article relative to this and other types of disintegration is to be found in Public Roads, Volume 24, No. 4 of April, May and June, as reported by F. H. Jackson, principal engineer of tests, Public Roads Administration. This disintegration, prevalent in the Northwest and West, appears more serious and pronounced than in the central states, where we believe our worst trouble comes from freezing and thawing. However, if there is any doubt as to the cause of your trouble with concrete. we recommend that you limit the alkali content of your cement, at least until such time as your aggregates are definitely pronounced non-reactive, as only 2 percent of reactive aggregates is enough to cause trouble.

Aggregates

Unsound, improperly-graded and segregated aggregates just about top the list as the cause of poor concrete. Unless your fine and coarse aggregates have already proved their durability in actual construction, they should be thoroughly investigated by sodium or magnesium sulphate soundness tests, or freezing and thawing tests, or both. Even if they have already proved their durability, there may be some doubt as to their reliability when used with present-day cement. Considerable importance is now being given to freezing and thawing tests on concrete test beams to determine their loss in flexural strength after several cycles of freezing and thawing, as flexural strength is more sensitive to freezing and thawing than compressive strength.

Trap rock and granite head the list as preferred coarse aggregates. However, sound, well-graded gravel, dolomite or limestone, and blast furnace slag, are considered satisfactory if they meet present-day specifications. Low absorption and high specific gravity are indications of sound aggregates.

Chert, shale and unsound particles are the worst offenders in gravel. Chert has all the appearances of a sound stone and, for that reason, is particularly treacherous. Some cherts are satisfactory for use, and we doubt if unsound chert can be distinguished from sound chert, except in the laboratory. Chert with a specific gravity below 2.35 is considered as definitely unsound. Shale should be kept to a minimum, as it disintegrates from weathering.

Dolomite is considered as tougher and harder than low-magnesium limestone. Both of these stones, when freshly quarried and exposed to the air, are subject to deterioration. Railroads are careful to select stones that are not subject to laminations, as some poor concrete is directly traceable to this defect. Most railroads prefer that crushed stone be washed. Excess dust on the stone is an indication that the stone is too soft. Sandstones are frequently friable or excessively porous because of imperfect cementation of the grains. Blast furnace slag is used extensively by highway departments, particularly in pavement work. It is more resistant to sulfate action than some stone. However, some railroads consider it too porous and subject to pop-outs.

Sand

In selecting sand, care should be taken to see that the grains are solid particles. Grains that are formed by the cementing together of many smaller particles tend to disintegrate.

Sand should be washed. The closer sand is to pure silica, the better. Sands high in silica, felspar and calcium carbonate will absorb very little moisture. Care should be taken to see that 12 to 30 percent by weight will pass the No. 50 sieve and 3 to 10 percent the No. 100. As most sands, when washed, do not contain this high a percentage of fines, it is often necessary to add additional fine sand. Sand manufactured from stone is not considered satisfactory. Natural sand taken from a pit where the gravel contains excess chert, or other deleterious substances, should be very carefully investigated. Only enough sand should be used to give a workable mix. Any sand over the required amount automatically adds more water to the mix, which is undesirable.

It is desirable that laboratory tests be made of all cements and aggregates available to your railroad, and that this information be readily available in order that the most suitable materials may be selected for any particular job without undue delay. You will not go wrong in specifying that aggregates meet A. R. E. A. or local state highway department specifications.

Curing

In curing is where most of us fail miserably in our efforts to obtain good concrete. When we consider that one of the main constituents of cement does not even start hydration for several days after pouring, and then only in the presence of water, and that from 50 to 75 percent of the effectiveness of the cement is lost if curing is stopped too soon, we can better understand why curing is necessary. Inadequate curing may affect only the outer shell of concrete, as farther inside the mass the retained water may be sufficient for curing. However, this internal concrete robs moisture from the outer shell, and if the outer shell does not have sufficient water, it will shrink while the inner concrete is expanding, causing the outer shell to check and crack seriously, and thus reduce the life of the concrete. Concrete expands and contracts with wetting and drying. The old method of applying curing water with a hose, then permitting the sun to dry out the concrete before applying water again, contracts and expands the green concrete until this outer shell, one might say, is "all worn out" before it is even ready to use. Both the amount of moisture for curing and the temperature of the concrete should remain as constant as possible.

Excess water is necessary for cement hydration. Theoretically, the curing should continue for several months. As this is impractical, it should be continued for not less than 7 days and, if possible, 14 days.

Curing compounds are now on the market and, in some instances, as when concreting close to electrical work, are absolutely necessary. However, we are of the opinion that there is no substitute for excess water, which must be present in order for the cement to hydrate.

The freezing and thawing of concrete while in a saturated or near saturated condition is another predominant cause of disintegration. To resist this, the concrete should be dense, with the coarse aggregate having a co-efficient of expansion as close as possible to that of the cement mortar, and non-absorbing in character, and using as low a water-cement ratio as possible to obtain a workable mix. In addition, the surface water must be kept out. If it cannot be kept out, it must be drained away quickly.

All horizontal exposed surfaces should be pitched to drain the surface. In addition, the top surfaces of bridge seats, wing wall, retaining walls, etc., should be thoroughly waterproofed to keep water from soaking in.

The backs of all walls must be drained and waterproofed. The form for the back of abutments and walls can be moved back two or three feet and left in place, the space between it and the masonry being filled with coarse crushed stone, inside which a complete horizontal and vertical drainage system is built. The prime coat of waterproofing should penetrate the pores of the concrete to be effective. Hot tar and asphalt, or tar and asphalt emulsions with suitable primers, are effective waterproofings for the back of walls. A prime coat of hot 50 percent turpentine and 50 percent raw linseed oil, with a second coat of hot, raw linseed oil, is effective for top surfaces, over which a good oil base concrete paint may be applied, if required.

Air Entraining

It is thought that the use of air-entraining concrete may prove to be a

greater asset to concrete durability than the development of the water-cement ratio theory. A. S. T. M. specifications are in force covering the use of both vinsol resin and Darex as air-entraining agents. Other air-entraining and dispersing agents are in use and are proving satisfactory. However, as yet, no authoritative specifications covering them are available, which limits their use.

Air-entraining cement may be purchased, or the agent may be added at the mixer. At the present time, it is recommended that it be added at the mixer.

Although air-entraining is still somewhat experimental, insofar as its use in structures is concerned, we think you should give it a trial in your structures. It will decrease somewhat the strength of rich mixes, but will increase the strength of lean mixes. Bond strength will be somewhat reduced. The water and sand content of the concrete, however, can be reduced, and workability and segregation of aggregates will be much improved, and bleeding reduced.

General

Following are some of the things the various railroads are now doing to improve their concrete, listed approximately in the order of their importance:

(1) Better selection and grading of aggregates.
(2) More care to prevent segregation.
(3) More attention to water-cement ratio and better water control.
(4) More careful curing.
(5) Better and more careful supervision.
(6) Specify compactness. Slump held as low as possible.
(7) Watch fine aggregate to get 10 to 30 percent passing No. 50 sieve and 2 to 10 percent passing No. 100 sieve, with fineness modulus of 2.40 to 2.80.
(8) Use only weight proportioning.
(9) Waterproof and drain backs of all abutments and walls, and waterproof top surfaces of all piers, abutments and walls.
(10) Indicate all pours and joints on the plans.
(11) All pours in one operation.
(12) Remove and waste top of pour after concrete has been in place long enough for the fines and laitance to come to the top.
(13) Better attention to details.

Much poor concrete is at construction joints. Joints should be detailed to keep water entirely out of and away from these joints. Concrete is often dumped into the form and worked toward the joint. Due to segregation and bleeding, an excess of water thus collects at the ends, resulting in concrete having less weather resistance at these points. Actually, the concrete should be kept slightly higher at the ends of the sections than at the middle.

On thin sections, leave an open joint. Tongue and groove joints in thin sections are not desirable. An effective water stop, caulking, or waterproofing applied over a joint at the back of a wall, is considered more effective than a lead or copper waterstop inserted in the wall. All vertical joints should be caulked or waterproofed across the top to keep moisture from getting into the joint from above. In any case, keep the water out or get it away fast. It is saturated concrete that disintegrates with freezing and thawing. Everything possible should be done to keep water out.

Placing

Vibrated concrete, when properly controlled, is superior to hand placed concrete. Vibration permits the use of stiffer mixes, which have less water and less tendency to segregate. It results in less honeycombing and fewer porous spots. If the mix is kept sufficiently stiff, the danger of over-vibrating is slight. The danger comes from vibrating too wet a mix, in which case serious segregation will occur.

Concrete should be placed in the forms as near as possible to its final position. Shoving it toward the ends of the form should not be permitted. Most of our poor concrete is at the ends of wings and at construction joints, where the concrete has been shoved some distance, causing segregation and water gain. Chuting into place is conducive to segregation and should not be permitted.

Aggregates should be proportioned by weight. It is hoped that automatic recording instruments will soon be available for both small and large jobs, so the man in the field can see at a glance the different weights of all materials that have entered every batch. A method of instantly obtaining the moisture content of sand would be a godsend to the concrete inspector, and would insure a more uniform and economical mix.

Concrete to resist sea water or alkali must be dense and impermeable, preferably employing sulfate-resisting cement. The reinforcement should have

at least 2½ in. coverage, and the surfaces of the concrete should be waterproofed with acid-resisting waterproofing.

Mixing water should be clear, fresh (not salt) and free of organic matter, acids, alkalis or other deleterious substances. In general, water fit for drinking purposes will be satisfactory for mixing, except in alkali-water districts, where all water should be tested.

Poor concrete is more liable to be at the top of pours, where the water and laitance collects. Concrete can be brought to the top of the form and allowed to set a short time, after which the top few inches can be removed and wasted, being replaced with fresh concrete. Or the concrete can be brought to within 12 to 18 in. of the top, then allowed to set a short time, after which the form should be filled with a drier mix.

Other Considerations

Concrete will settle away from structural steel members or reinforcing steel anchored near the top of high pours, causing voids which will later collect damaging water. The only suggested remedy is to pour to the underside of the steel and allow the concrete to set enough to eliminate at least some of the settlement. For this reason, round horizontal reinforcing is preferable to square bars.

Expansion joints in retaining walls should be spaced 20 to 30 feet apart, preferably constructed so each section stands alone. Reinforcing steel across a construction joint is not desirable, and a vertical keyway tends to collect water which may develop a head, in addition to reducing the concrete section at that point. It would seem good practice to drain the bottoms of construction joints.

Expansion joints in pavements at 100-foot centers, with dummy joints 1¾ in. deep on 20-foot centers, is good construction.

One railroad obtains good wearing floors and pavements by using trap rock or other tough stone for a topping. The concrete is mixed with not more than 3½ gal. of water per bag, which requires the use of a mechanical float. The surface is then troweled and later roughened with fine bristle brushes. If exposed to the weather, air-entrained cement is used. Adequate water curing is insisted upon. Heavy-duty floors can be constructed in two courses, with a top finish ¾ in. to 1 in. thick, containing tough pea gravel or other small size durable aggregate graded from ⅛ in. to ⅜ in., applied to the base slab before it has taken its initial set. This should be placed as stiff as possible, with a 1:1:1½ or 2 mix, using a power float. A mortar topping should not be used for heavy-duty floors or bearings under heavy load. Several railroads use iron troweled into the finish coat for inside floors, with favorable results, except for some discoloration.

We are well aware that this report omits entirely many important questions concerning concrete and barely mentions some in which you are intensely interested. The subject is much too broad to cover in one report. The best we can expect is that this will serve as a stepping stone to further work on this subject.

Conclusion

To improve the strength, durability and wear resistance of concrete exposed to the elements, design for strength in accordance with the water-cement ratio and use as small an amount of sand and cement as possible to obtain the desired workability. Use well-graded, durable, non-absorbing, non-laminated coarse aggregate, with durable sand having sufficient fines. Use low-alkali cement unless positive your aggregates are non-reactive with alkali. Provide adequate drainage. Waterproof the back sides of all walls in contact with earth, and waterproof all exposed flat surfaces. Prevent all trapping of water. Weigh the aggregates. Provide adequate curing. Use air-entrainment if subject to freezing and thawing and, above all, provide adequate skilled supervision.

Bibliography

Expansion of Concrete Through Reaction Between Cement and Aggregates, by T. E. Stanton, A. S. C. E. 1942 Proceedings.

Research on Concrete Disintegration, by H. S. Mattimore and G. H. Rahm, Jr., Proceedings A. S. T. M. Vol. 35, 1935.

Concrete Deterioration at Parker Dam, by R. F. Banks, Engineering News-Record, March 27, 1941.

Approach to Design Concrete Aggregates, and Aggregate Selection and

Control, by C. E. Wuerpel, Civil Engineering, August and September, 1939.

Entrained Air in Concrete, A Symposium, Journal-American Concrete Institute—June, 1946.

A Study of Chert as a Deleterious Constituent in Aggregates, by H. S. Sweet and K. B. Woods, Engineering Experiment Station—Purdue University.

DISCUSSION

J. A. Jorlett (Penna.) stated that his road was having difficulties with disintegrated concrete, having spent in the neighborhood of $500,000 for relining two tunnels alone. The concrete for this work was placed in the forms by the pumping method with good results, he said.

Utility and Economy of Prefabricated Buildings

Report of Committee

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THE subject of prefabricated buildings covers any type of building formed of sections or panels of floor, wall, ceiling and roof units, which can be assembled and erected in the field more rapidly and with less labor than conventional buildings constructed entirely on the site. It also embraces entire buildings which can be moved from one location to another without dismantling.

Probably the first portable buildings to be used by the railways were box car bodies or portions of box cars. These have been used to house employees and for offices, tool houses, etc., and all bridge and building men are familiar with their advantages and disadvantages.

Concrete Buildings

One well-known company now has on the market a precast concrete building, available in different sizes with the following inside plan dimensions: 6 ft. by 6 ft.; 6 ft. by 9 ft.; and 8 ft. by 10 ft. These buildings are complete with door, window and roof ventilator, and can be used to house equipment or materials at outlying locations or as watchman buildings. They are attractive in appearance, are fireproof, and will not be damaged by wind or inclement weather. In addition, there is little chance of their being damaged by vandalism. They can be equipped with racks or bins and valuable electrical or signal apparatus, or oil, gasoline, fusees, etc., can be safely stored in them.

No foundation is required for these buildings, except in some locations where unusually soft ground is encountered; no painting is necessary, except for the door and the window frames, and they can be moved in their entirety from one location to another. However, their weight is from 11,000 lb. to 19,000 lb., which, in most cases, requires that a crane be used to load and unload them.

The prefabrication at the mill or shop of some parts of buildings, such as window sash, doors and their frames, cupboards, racks and closets, has been standard practice for many years. A little later we began to use wallboard and roof slabs, and in some cases roof trusses. It is only within recent years, however, that there has been mass production of prefabricated buildings which can be readily erected at one location and, after serving their purpose in that location, can be taken apart and reassembled rapidly at a reasonable cost in another location. This industry producing such buildings is still in its infancy, but may grow to be a good-size child, and probably to full manhood, as numerous companies are organized in all parts of the country to produce prefabricated buildings.

These manufacturers furnish prefabricated sections to form the floor, roof, enclosing walls and interior partitions, complete with bolts, etc., but it is necessary for the railroad to erect the struc-

ture. Most of the companies in this business to date are specializing in prefabricated houses, and leave it to the erector to install the foundation, chimneys, plumbing, drainage, and electric wiring and fixtures. Some producers of prefabricated houses furnish the plumbing and the kitchen and bathroom units, which reduces materially the amount of work in the field.

Steel Buildings

Some prefabricated buildings of steel are erected with comparatively light structural steel frames and roof trusses, and are covered with steel sheets in proper shapes to fit. In some cases these have panels lined with insulating board, which makes them more comfortable and adds to the appearance of the interior. This type has been used for many years for tool sheds, motor car houses, garages and similar structures.

One manufacturer has been furnishing prefabricated steel buildings for more than 25 years. This company will design and furnish the material for a building of almost any size. One eastern railroad has a warehouse furnished by this manufacturer, 160 ft. by 1,300 ft., and the same road has prefabricated buildings as small as four feet in width. The same manufacturer has furnished material for locomotive shops, car repair shops, etc.

Another type of steel building is the steel-panel type, which is formed of shop-fabricated galvanized sheets having interlocking flanges. The panels are self-supporting and load bearing, the structural strength being obtained by the folded interlocking flanges of the individual steel sheets. Field assembly is accomplished by fitting the panels together and securing them to the foundation. The panels are formed from 18 to 22-gage metal in 16-in. widths, and of various depths to suit the structural requirements of the building in which they are to be used. For floors and flat roofs having longer spans, the panels are made narrower and of 12 gage material. All bolts, screws and other fastenings are of galvanized or cadmium-plated steel.

The buildings are erected upon a base angle secured to a concrete foundation by anchor bolts. Between the foundation and the base angle an asphalt-felt strip is inserted, which serves as a cushion and moisture barrier. The exterior wall panels are erected with the face cut to form the exterior surface. Wood furring strips are fastened to the inner projecting flanges and serve as a nailing base for the application of the interior wall surfacing. Lath and plaster, plywood, or various kinds of wallboard may be applied. When insulation is desired, rock wool batts may be applied between the wall surfaces.

Pitched roofs are constructed of panels erected with the flanges upstanding, forming tight, self-flashing ribs. The roof panels are painted and require no further waterproofing. The roofs may be either flat or pitched. Floors may be of concrete or of wood panels carrying a wood sub-floor and a finished floor of wood or other material.

The finishing of a steel building and the installation of the mechanical and electrical equipment are carried out in practically the same manner as for a building of conventional construction. The size of these panel-type buildings ranges from 8 to 24 ft. in width, with variable lengths. The surface permits painting immediately after erection, if desired.

One railroad has a colony of nine of these buildings each about 10 ft. by 20 ft., to house construction laborers. This colony includes bunk houses, a kitchen, and a recreation and bath house. The railway prepared the concrete foundations and the buildings were erected under contract, thus benefiting by the use of experienced workmen. These small buildings, in 1945, cost approximately $325 each, plus about $150 additional for erecting them.

The company that furnished these buildings makes steel buildings of various sizes. One size, 8 ft. by 8 ft., and 8 ft. high, cost $120 in July, 1946. Another size, 12 ft. by 20 ft., with 8-ft. sidewalls, cost $270. A building 24 ft. by 40 ft., with 10-ft. sidewalls, cost about $850. These prices all f.o.b. Chicago, did not include doors, windows and ventilators. Ventilator-type windows cost approximately $15 and doors vary from $25 to $100 each, depending upon type and size.

One company makes a "mastic-protected metal" roofing and siding, in either corrugated or flat sheets. The mastic replaces galvanizing and rolled methods of bitumen application. The clean uncoated sheets or prefabricated shapes are dipped in a mastic preparation, after which a mineral coating is applied to protect the surface. Thus, the finished surface does not require painting and is virtually free from any maintenance costs.

Redwood Siding

One manufacturer of frame buildings uses clear, all-heart California redwood T. & G. siding. The panels for the side walls are obtained in 8-ft. sections. The standard width of these buildings is 20 ft., but the length may be varied in multiples of 8-ft. One eastern railroad has erected 35 of these buildings, all 20 ft. wide, but in lengths of 16 ft., 40 ft., 56 ft.. 72 ft., 88 ft., and 256 ft.

The wall panels are 3⅝ in. thick, of flush construction, and are so designed that part of the roof load is taken through the vertical siding. The windows and doors are an integral part of some panels, requiring no field fitting or setting.

The framing of the side walls and flooring consists of 2-in. by 4-in. and 1-in. by 6-in. or 1-in. by 8-in. lumber, respectively, of Southern pine, spruce, fir or hemlock, No. 2 grade or better. The ceiling joists are 2-in. by 6-in. pieces on 24-in. centers. Where floor insulation is desired, double floors, with 3-in. batt insulation built into the floor panels, can be had.

Usually, buildings of this type are placed on a pile-butt foundation. However, concrete slabs are sometimes substituted when a more permanent type structure is desired. After the buildings are erected, they are painted with the railway's standard color. Toilet and electrical fixtures are provided when desired.

Buildings of this type have been used as living quarters for imported labor. They are also being used successfully to house section foremen and their families. In several instances they are used to store chemicals in connection with water-treating stations.

One manufacturer of prefabricated plywood buildings has provided several railroads in the East with material for bunk houses, kitchens, dining halls, recreation halls, tool houses and warehouses. The basic unit of these structures is either 16 ft. or 20 ft. wide, and 8 ft. long, and any number of these units can be put together, with cross partitions between them, as desired.

These buildings are made with weather-proof plywood walls over a rigid frame; are delivered knocked down, ready for quick and easy erection on piers or block foundations; and are completely demountable for removal to another site. All floor, sidewall, end wall and roof sections are interchangeable. This permits them to be used again in new combinations, in varying lengths to suit conditions.

One company manufactures barrack-type units of both plywood and wallboard construction, and has furnished many of the southern railroads with buildings in 20-ft. widths. Its price list in 1945 lists a 20-ft by 20-ft. plywood building at $635; a 20-ft. by 100-ft. plywood building at $2,435; a 20-ft. by 20-ft. wallboard building at $670; and a 20-ft. by 100-ft. wallboard building at $2,545. This company also sells foundation blocks.

Railroad Has Own Design

One western railroad reports that it has used many prefabricated buildings, built to its own design. These buildings are built of units of such size that they can be easily handled by two men, and with units interchangeable; that is, all floor sections are similar, as are sidewall, end-wall and roof sections. Of this design, the buildings are limited in width, but they can be built to any length in multiples of six feet. They are sheathed with waterproof plywood, insulated on the inside with fibreboard.

End-wall sections are equipped with doors, and side-wall sections with windows. The various sections have been constructed on jigs near the source of lumber supply, and have been shipped bundled, as required, for a complete building. All sections are fastened together with bolts, making assembly and dismantling easy. These buildings were constructed at a cost far below the cost of similar structures built separately.

The same railroad has used similarly constructed buildings built and assembled at a central point. These buildings, which are used as labor houses, tool houses, dispatchers' offices, storehouses, etc., are 9 ft. by 32 ft., and are constructed on skids so they can be skidded onto a flat car, or they are lifted with a locomotive crane.

Some railroads are prefabricating buildings in their own shops, as their shop labor is about 35 per cent lower in cost than their field labor.

Some manufacturers have developed their assemblies for two-story structures, with limited floor loadings. Such buildings should be discouraged for railroad use because, after construction, they may be used for a purpose entirely different from that intended originally, and excessive floor loadings may cause collapse.

Some railroads have used automobile trailers to some extent, not only to house laborers, but also for foreman offices. In some cases employees use their own trailers to live in. However,

the committee has not been able to procure enough data on the use of trailers to make report on them at this time.

The main advantage of prefabricated buildings for railway use are that they can be constructed much more rapidly than buildings of conventional design, and that they can be dismantled and reassembled in different locations if circumstances should require. In many cases also, prefabricated buildings can be erected at a lower cost.

Prefabricated frame buildings are light in weight, are easily handled and quickly erected. They are comparatively low in initial cost and can be erected at a relatively low labor cost. Their unit construction and unrestricted length afford flexibility to suit a considerable range of railway needs. For these particular purposes they have proven satisfactory.

The steel buildings are reasonably light in weight and afford a marked advantage in ease and rapidity of erection. They are of water-tight construction and are resistant to the attacks of termites and rodents. Since they are of steel, they command a lower fire insurance rate. Most manufacturers use a metal with a special surface treatment, so that immediate painting is permitted in any color desired. Also, this metal is supposedly rust resistant, so that painting can be postponed. It is believed that the ultimate cost of the steel buildings on an annual basis will be less than that for similar buildings of frame construction, since the steel buildings will require less maintenance. Although both the frame and metal buildings are demountable, it is believed that the steel buildings have the advantage that they are practically 100 per cent salvageable for use in another location.

There are also some disadvantages to the use of prefabricated buildings. The primary objection to such buildings of more than one story has been stated previously. In some localities, prefabricated buildings will not harmonize with the existing buildings and surroundings.

In many instances, city, town and village codes and ordinances do not permit the erection of prefabricated buildings, as the construction and materials do not comply with the code or ordinance requirements. It should be remembered also that frame structures are prohibited within the fire limits in practically all communities where building codes have been adopted. Both the steel and frame buildings generally have the added handicap of not complying with codes insofar as the thickness of framing members is concerned. It is important, therefore, to be sure that any buildings purchased meet with the minimum fire-hazard and safety requirements of existing building codes where they are to be used.

Each building problem should be studied individually before prefabricated construction is started. The use to which any building is to be put is most important. Occupancies introducing heavy loading and rough operations may call for extraordinary maintenance and repair, entailing expenditures which, coupled with the initial cost, will far exceed the cost of a more permanent type of structure.

DISCUSSION

In answer to a question raised by F. G. Campbell (E.J.&E.), H. M. Church (C.&O.) stated that the employee organizations representing building construction and maintenance men do not object to the railroads' use of prefabricated buildings because there is more building work to be done on railways than the employees can do, and the erection of the prefabricated buildings is carried out by railroad forces.

W. A. Huckstep (M.P.) pointed out that the use of prefabricated buildings was especially attractive at this time when, because of priorities in favor of war veterans, it was impossible in some cases to procure the necessary materials for conventional buildings.

L. E. Peyser (S.P.) stated that his road has used many prefabricated structures for housing Mexican laborers and for tool houses and telephone booths. He pointed out, however, that this type of building generally has a limited service life. When F. W. Hutcheson (C.&O.) declared that prefabricated buildings of steel will withstand more dismantling and moving than those of wood, Mr. Peyser stated that his road uses bolts and not nails in erecting prefabricated wood buildings as a means of preventing damage to the parts.

Cause and Prevention of Injuries to Bridge and Building Employees

Report of Committee

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SAFETY conditions would be improved and casualty rates correspondingly lowered if men would observe rigidly the old axiom concerning wild animals which goes as follows—"Self preservation is the first law of nature."

Man is not inherently safety minded; he must be taught safety to understand it and to put it into practice. Nearly all of his actions are ruled by habit and, although he may seek perfection in improving his habits, if encouraged and guided, he still may never become infallible. To accuse an employee of being unsafe before he understands what he is being charged with will naturally cause him to become resentful, and then his co-operation in the promotion of safety cannot be expected.

Great strides have been made during the last quarter century in the promotion of safety. There are two basic obstacles to be overcome in the elimination of injuries:

(1) Environment, unsafe tools, etc.
(2) Man failure.

The elimination of unsafe, defective and obsolete tools, together with other safety hazards, has been well carried out. Nearly all accidents due to these causes are the result of man failures. Generally speaking, management no longer tolerates these conditions. When supervision and employees can reduce man failures to the extent that management has reduced hazards, then safety will have become a reality.

Many Hazards

Bridge and building employees are exposed to the dangers of personal injuries, more perhaps than any other class of railroad workmen. Their work entails exposure to a constant variation in hazards with each new day. Each job presents its own difficulties, even though it may be similar to another done previously, but in a different location. Most bridge and building employees have a constantly changing scene of action. A bridge gang may be repairing an enginehouse roof one day, and off to a pile-driving job the next. It may be repairing a trestle across a small ravine today, and tomorrow working at dizzy heights on a bridge over a rushing torrent. Under conditions such as these, the B. & B. employee must be on the alert at all times. He must be able to adjust himself to great differences in working conditions.

Common Causes

The more frequent causes of personal injuries are as follows: Inattentiveness, resulting in falls; being struck by moving objects, etc.; motor car accidents, such as collisions with trains, vehicles, other motor cars and animals; tools and materials falling off cars, causing derailments; fires due to broken or leaky gas lines; excessive speed; failure to observe obstructions on tracks and the flangeways of crossings; open derails and switches; improper drawbar connections; collisions due to operation in fog, snow or darkness; use of defective tools, scaffolds and equipment; wrenches or bars slipping; and the improper handling of power tools and machines. Injuries resulting from the improper handling of material are numerous. Foot injuries in this class can be reduced materially by suggesting to employees that they wear safety shoes.

Occasionally, an accident results from an explosion or fire due to cleaning fluid, natural gas, paint mixer, etc.; an explosion of compressed air containers; explosions when heating tar or creosote oil; electrical shock, resulting from booms, hoists, cables, guy wires, tape lines or tools coming in contact with wires carrying electrical current; and improper grounding, faulty insulation and contact with the electrodes of welding sets.

Generally, all excavations of four feet or more in depth should be strutted, except where very stable material is being excavated. Unusual care must be exercised where alternating layers of material are encountered, such as clay and sand, gravel or cinder; also quicksand. In these instances, excavations must be thoroughly cribbed and should have sufficient struts, well braced vertically and horizontally.

Cranes and Pile Drivers

The use of locomotive or crawler cranes by inexperienced foremen and operators should not be allowed. Cranes should not be used for loads greater than their capacity at any given radius. In handling heavy loads, especially with a single line, there is a distinct advantage in lowering the load with the boom, instead of using the brake on the line drum. Outriggers or rail dogs should always be used in case of doubt when handling heavy loads with locomotive cranes. Cables, sheaves, drums, frictions and brakes must always be kept well maintained. One man, preferably the foreman, should be delegated to give signals for all moves. Constant vigilance should be maintained to prevent cranes being moved into the paths of trains, objects, etc., and to avoid swinging the boom too near wires carrying electrical current.

Pile drivers are the source of many personal injuries. A competent foreman, top man and operator, are essential to safe operation. One person should give all signals to the driver operator, and should always be in a position to be seen by the operator and foreman on the ground. All cables, leads, toggle blocks, etc., should be well maintained. In the case of steam hammers, particular attention should be given to the steam hose, as a broken steam hose or slipped connections can cause serious burns. Extreme care should be used in placing piling in leads, or in raising or lowering the hammer, so that the steam hose is not caught or pinched, causing failure.

Gin poles should be properly anchored and well guyed. The use of three or more guy lines is desirable for extra heavy lifting. The type of guying must be determined by the character of the work being undertaken, as there are instances when more than two guys can not be used.

Explosives

The handling of explosives and combustible materials is generally well covered by the rules and regulations of nearly all railroads and the Interstate Commerce Commission. Placards on this subject should be posted in conspicuous places. All employees should be taught methods of safe handling of explosives and combustible materials, and handbooks and literature relating to this subject should be passed around among all employees. Carelessness should never be tolerated in the handling of explosives. Only capable, alert and conscientious employees should be assigned to handle them. Numerous accidents each year can be attributed to the improper handling of the gasoline used in the motor cars and machinery used by B. & B. gangs. Gasoline should be handled in approved type safety cans. Smoking and open-flame lights should be absolutely prohibited in the vicinity of gasoline. Repairs to gasoline tanks should be made only by experienced mechanics.

Fixed Scaffolds

Scaffolding of some type is used on practically all bridge and building jobs. Both steel and wood are commonly used for scaffolding of the suspended or built-up types. Both have advantages; steel scaffolds are preferable for jobs of long duration, particularly for work at higher elevations, and are not subject to fire hazards, have more resistance in high winds, and do not occupy as much space. Furthermore, they are easily removed without much damage. However, light tubular, sectional steel scaffolding is designed to carry given loads of men and materials, and because of this feature, its use may be restricted to a certain extent.

Lumber is carried on cars for many classes of maintenance work, and is usually available for scaffolding on all construction jobs. However, the material on hand is not always suitable. It may be second-hand, knotty, checked, and badly warped, or it may not be of the recommended soft pine woods. Because wood scaffolds are usually of a

temporary nature, their importance to safety is sometimes neglected in the choice of materials, design or workmanship. This is false economy because it creates the possibility of accidents. Wood scaffolds should be built with specified materials, and should be provided with railings and solid toe boards, including wire mesh between toe boards and railings, as a precaution against tools and material falling off the platforms when working over streets, alleys and walks, or adjacent to windows and doors.

Scaffolds are usually designed to carry known loads, with a safety factor of 3, after allowances have been made for defects in materials. Adequate bracing against shock and wind are important. Soft woods are recommended, preferably straight-grained pine of the structural type. This is particularly true of platform plank, which should be at least 2 in. thick, and a minimum of 10 in. wide to reduce the tendency to overturn. When more than one width is used, platform plank should be cleated together on the bottom side. A sufficient number of platform plank, conforming to recommended sizes and quality, should be carried in stock and marked so they will not be used for any other purpose.

Swing Scaffolds

Swing scaffolds are used commonly for repair and paint jobs at high elevations, on such structures as water tanks, stacks, coaling stations, bridges and buildings. The use of such scaffolds involves a number of hazards not common with other types. For this reason, only employees who are thoroughly familiar with these hazards should erect or use them. Hangers may be of one-piece iron, passing underneath the platform, to which railings and toe boards are fastened. Some, however, prefer the heavier type, made up of framed timbers assembled with bolts and rods, with cable slings and rings at each end, to which tackle is fastened. Tail lines are used to guide or adjust scaffolds to position, and to prevent swinging.

The question of safe anchorage and block and tackle is equally important, and must be prescribed or approved for each particular job, mainly because the relative strength of various kinds of rope, cable, chains, metal hooks, rings and blocks is often assumed, and not always known. Safe anchorage is so important that more than one supervisory officer should check and agree on the location and part of the structure to which tackle is to be anchored, such as cornice, eaves, fire escapes, stacks, ventilators, railings.

Barricades and warning signs are an added precaution, and are often necessary to prevent the public, vehicular traffic, and cranes and other power equipment from coming in contact with scaffolds and guy lines. Scaffolds erected adjacent to a track must conform with prescribed safe clearances, or be protected by close clearance signs, slow orders, slow signs and flagging, depending upon whether main track, siding or yard track, and the traffic involved.

Men working from scaffolds that are dangerously close to moving machinery, belting, gears, shafting, or to electric power lines, must have a definite understanding as to how the work will be accomplished safely if it is not possible to shut the power off during the period when work is under way.

Falls

Injuries sustained from falls are usually of the more serious type and, proportionately, are greater in number than any other class of accidents. Falls are usually due to one or more of the following causes:

(1) Overloading, defective materials, faulty design.
(2) Lack of railing or toe boards, or both.
(3) Falling objects, such as refuse, materials and tools.
(4) Failure of floor boards.
(5) Failure of tackle.
(6) Wind, fire.
(7) Carelessness.

Cutting and Welding

A number of precautions must be observed in cutting and welding. The use of a cutting and welding torch always presents the hazard of fire and burns. It should never be permitted around highly inflammable or combustible material. When necessary to do this type of work where there is danger of fire, a suitable type of fire extinguisher should be at hand for immediate use. Also, where deposits of grease or oil are involved, a bucket of sand should be kept readily at hand. Operators must be extremely careful to avoid fire in their clothing, and burns on their bodies from splatter. The use of asbestos gloves for welding and cutting is recommended. Operators should be prohibited from the use of cutting or

welding torches without prescribed goggles or shields. Employees in the vicinity of this type of work should be cautioned against watching the operations without using dark glasses. The use of shields at regular welding or cutting benches is desirable. In shops where work of this character is done regularly, a bench with fire-brick top, along with a concrete or metal-covered floor, is advisable.

Other Precautions

In electric welding the arc flashes are very hazardous to all persons in the immediate vicinity. Shields should always be used where other persons are working. Serious eye injury or headaches are caused, even though a person does not look directly at the arc, as the flashes will penetrate from the side of the eye. Proper grounding, well-insulated electrode holders, and freedom from dampness, will eliminate numerous chances for accidents. Care must be exercised in the handling of electrode holders to prevent contact with the body.

The repair of oil, gas or naphtha tanks, or of tanks or containers that hold or have held any inflammable material, should never be undertaken except under the supervision of a competent person who is thoroughly versed in the rules pertaining to this class of work. The tank or container should be thoroughly washed or steamed, aired and dried out before any welding is done, and no work should be undertaken without all vents and openings being clear, to allow the escape of vapor.

Air and Electric Tools

The use of air and electric tools is steadily increasing and constitutes additional hazards when not done properly. Only men who are mentally alert and physically fit should be assigned to operate these tools. Incompetent operators can cause injury to themselves and other nearby employees. Operators should be thoroughly instructed in the safe and proper handling of these tools. One important item to be stressed is: never become careless in the handling of power tools. The improper use of any tool may cause a defect not readily noticeable. Continued use may cause personal injuries.

Pneumatic tools and equipment are a source of numerous injury possibilities. If hoses are allowed to become damaged through carelessness, or are used after they have become too old to sustain pressure, an accident may result. We all realize the danger of a loose, flying air hose. The constant roar of the compressor and the racket set up by tools make it necessary for the workman to depend upon his eyes alone for safety when working near other equipment, such as derricks, pile drivers or power shovels. Workmen must be taught to be on the alert at all times. Electric tools and equipment, unless kept in first-class condition, are apt to cause personal injuries, such as shock and burns, that can be fatal under certain circumstances. Proper maintenance and thorough instructions to operators mean fewer personal injuries.

Motor Car Accidents

There are thousands of track motor cars in operation every day. An appalling number of these cars are involved in accidents each year, which are resulting in numerous fatalities and serious injuries. This needless sacrifice of life and untold suffering occurs annually, and although for years new rules, new teachings, and improved methods of examination have been promulgated and put into effect, they have failed to stem the tide of motor car accidents in the same proportion as other types of injuries. With few exceptions, motor car accidents have been adjudged preventable. For the most part they have occurred because the person in charge of the car failed to use good judgment, either because he failed to observe the rules that govern, or because one or more employees were derelict in their responsibility and duty, even though not directly involved in the accident.

The responsibility for the safe operation of a motor car rests, obviously, on the motor car operator first, and on the foreman, if in charge. Safety engineers and railway officers, as a group, seldom fail to agree on who must bear the burden of responsibility. Who is responsible is thoroughly covered in the safety and operating rule books common to all railroads operating motor cars.

It is the consensus of railroad managements and operating and maintenance officers that motor car operators are responsible for the operation of their cars and the lives of all who ride with them. It follows, therefore, that the qualifications for this position must be of a very high order—much higher than have been set for many who operate cars today.

In the past few years there have been a number of very serious motor car

accidents due to coupling bars becoming disengaged and dropping down and derailing a trailer car or truck car. There is evidence that insufficient attention is being directed to the use of a standard coupling bar with pins equipped with automatic positive locking devices. As bolts and nuts equipped with cotter keys are often hard to remove without tools, there is a tendency to use the bars without nuts or cotter keys on the pins. This practice eventually results in a serious accident.

Motor car operators must be made to realize that trains today operate at much higher speeds. They must be impressed with the necessity of security line-ups or orders for the operation of their cars whenever it is possible to do so. When there is any doubt as to the locations of trains, flag protection, torpedoes and fusees should be used. It is very desirable that there should be additional wayside telephones at or near obstructions to view. Consideration should be given to furnishing each motor car with a portable telephone where wire service is available. The general and successful use of radio communication in the last war would suggest the future possibility of radio-equipped motor cars.

The managements of some railroads have resorted to the use of automobiles and highway trucks by their track and bridge and building forces to reduce the hazards of personal injuries and train derailments caused by track motor car operation. Reports of these roads indicate a considerable reduction in man-hours and injuries by this practice.

Motor car operators should be examined at least every six months on safety, operating, and motor car rules by a qualified examiner. Supervisors should keep a constant check on individual operators to see that they do not become careless. They should also impress upon all others riding on motor cars the importance of being constantly on the alert, in the interest of self-preservation and the welfare of other employees.

The actual responsibility for the teaching of safety to employees must, necessarily, rest with supervisors and foremen. They must start the new man on the right path with a system of teaching and education. They must watch over the older men to see that they do not violate the safety rules and teachings, and they must, at all times, exemplify their teachings on safety. Employees can not be expected to live up to the rules and teachings if their supervisory officers are constantly breaking safety rules.

Not all accidents are preventable. But when the time arrives that we can say our only accidents in a given year are those that could not have been prevented, we shall have a safety record and casualty rate of which we can be justly proud.

Safety Meetings

All railroads have some system of safety education. One of the better methods is to hold regular safety meetings, if at all possible. These meetings should be conducted by the employees themselves, with someone present who can advise and carry suggestions along to the proper authorities for action, if action by higher officers is necessary. In these meetings, the employee should be made to feel free to present any suggestions or facts that he feels will improve the safety record of any particular man, gang, or the railroad as a whole. Every statement at these meetings should be given careful consideration, even though some of them may sound unreasonable or unnecessary.

The analysis and discussion of all accidents occurring in the previous period, regardless of whether reportable or non-reportable, have been found to be very beneficial in determining the causes and methods of preventing the repetition of these accidents. The frank discussion among employees of unsafe practices and unsafe conditions observed in their daily contacts will do much to prevent personal injuries and lost time.

Foremen and gang leaders should be chosen for their ability to direct the work in a manner that will insure safety as well as efficiency. Good common sense and the ability to handle men, as he himself would like to be treated, are extremely important to the foreman. Respect for the men under his jurisdiction will do much to promote harmony, and thus cause the work to be carried on in a safe and workmanlike manner.

Safety Rules

A practice adopted by numerous railroads, and a good way in which to keep safety uppermost in the minds of employees, is the "rule-a-day" practice, under which a selected rule is required to be read to all men of each gang before starting the day's work.

Good results can be obtained in reducing casualty rates if supervisors

and foremen will rigidly observe the following teachings and rules:

(1) Instill the idea of self-preservation in the mind of each new employee.
(2) Impress upon him the importance of preventing accidents to others.
(3) Teach him to be constantly on the alert.
(4) Keep his mind free of family or other outside troubles.
(5) Teach and thoroughly explain to him all working and safety rules.
(6) Allow no one to willfully break safety rules.
(7) Talk safety constantly.
(8) Practice safety and live safely.
(9) Prevent hazardous conditions.
(10) Sideline the employee who can not or will not accept and practice the teachings of safety.
(11) Require the use of goggles as eye protection.
(12) Rigidly enforce rules pertaining to the use of defective tools or materials.

Safety education along the foregoing lines will tend to produce safety-minded employees, and then the goal of "no accidents" will be in sight.

In conclusion: always remember that "haste makes waste." Even though a "featured" train may be delayed by taking time to do work safely, never forget that outstanding slogan, SAFETY ABOVE EVERYTHING.

DISCUSSION

Answering a question raised by J. S. Hancock (D.T.&I.), Chairman Curie stated that the only way to determine when a hose is worn out and unsafe is by cutting off a piece and inspecting the inner lining.

W. A. Sweet (A.T.&S.F.) mentioned that a safety valve is now available, which can be attached to an air hose for assuring a uniform flow of air. In the event of a break in the line, the valve prevents the rapid expulsion of air and the whipping of the hose line.

The practice of equipping bridge gangs with portable telephone sets is becoming more widespread, Chairman Curie said, because such sets not only assist in obtaining information on train schedules, which is essential in safeguarding the movements of men on motor cars, but they also reduce the necessity for stopping trains while work is in progress and permit more complete utilization of the gang's working time. Further discussion on this subject by L. H. White (I.C.), S. L. Chapin (S.P.), W. F. Martens (A.T.& S.F.), and V. W. Hutchings (S.P.) developed that the portable telephone set of the foreman is connected to the dispatcher's line while those furnished flagmen are usually connected only to the foreman's set.

Mr. Chapin spoke of the importance of grounding all electrical power tools, a practice that is made mandatory by law in some states—to preclude injury to workmen by electrical shock.

Tools and Equipment for Bridge and Building Shops

Report of Committee

H. E. Davis (chairman), supvr., b. & b., N. Y. C., Chicago; P. B. Collier (vice-chairman), b. & b. supvr., M. P., St. Louis, Mo.; P. F. McNally, Sr. (vice-chairman), asst. b. & b. supvr., S. P., Ogden, Utah; H. E. Skinner (vice-chairman), br. insp., E. J. & E., Joliet, Ill.; F. G. Campbell, asst. ch. engr., E. J. & E., Joliet, Ill.; G. S. Crites, div. engr., B. & O., Baltimore, Md.; A. B. Hillman, engr. m. of w., C. & W. I.-Belt, Chicago; E. R. Johnson, salesman, Harron, Rickard & McCone, Los Angeles, Cal.; A. A. McDermott, b. & b. supvr., S. P., Dunsmuir, Cal.; J. M. Salmon, Jr., asst. br. insp., L. & N., Louisville, Ky.; C. J. Shapland, asst. engr. b. & b., C. V., St. Albans, Vt.; William A. Stewart, supvr. br. (retired), C. V., Stafford, Conn.; Liu Tseng-ta, Chinese trainee, C. M. St. P. & P., Union Station, Chicago; J. L. Varker, b. & b. supvr., Delaware & Hudson, Carbondale, Pennsylvania.

THE use of modern tools and equipment by the bridge and building forces is being given much consideration by all railroads, but it must be given even more if they are to keep a jump ahead

of rival forms of transportation. We—in the B. & B. department should be furnished more modern tools to enable us to secure the skilled labor and economy of operations that we should have in this great industry of ours.

The establishing of large bridge and building department shops at various points along our lines must be determined, of course, by the number and character of structures and other facilities to be maintained. On some roads, one large shop, centrally located, may be desirable, but on most roads a shop should be established on each division. In addition, the larger divisions should also be equipped with portable B. & B. shop outfits in cars.

Where large permanent shops are to be established, it is desirable that all tools and equipment be in one fireproof building, which should be located near the storehouse to facilitate the handling of materials for all classes of work. A stake-body truck should be a part of the equipment of the shop to enable the quick delivery of materials to outlying points. Portable shops should consist of a tool car, preferably a baggage car, equipped with power tools.

Electricity should be available for all shops, with sufficient outlets to handle all power tools. For each portable outfit an adequate generating plant should be provided. Likewise, compressed air should be available at all permanent shops, secured from stationary compressors, with plenty of outlets, and portable compressors should be furnished for portable shops, where necessary.

Layout

The layout of a division shop should be large enough to accommodate all of the crafts involved, with ample space to operate each piece of machinery without interfering at any time with any other piece of machinery. ("Safety first" being paramount.) To accommodate carpenters, pipe-fitters, sheet-metal workers, machinists, and a small paint shop force, the building should have from 4,000 to 6,000 sq. ft. of space, with the quarters of the various crafts segregated, and with a foreman's office near the center of the shop. The various machines and work benches, should be located near the walls, with sufficient windows for good daylighting and air circulation.

On some railroads the bridge and building forces handle motor car and roadway equipment repairs. Where this is done, the equipment repair shop should be separate from the main B. & B. shop, with space of sufficient size to house all of the equipment that comes in. One end of the shop should be used for light repairs, and the other end for heavy repairs; both ends being served by a mono-rail system, or, the equivalent, with a power hoist.

Bridge and building road gangs should have one car equipped with work benches and portable power tools, and this car should contain a generator for furnishing electricity, as these outfits are located many times where electricity is not available.

Tools and Equipment

All large division shops should be equipped as follows: Tilting double-arbor table saw, with 16-in. saws; rip saws, 16-in. to 18-in. blades; band saw; mortising machine with drill-bit attachment; 24-in. planer; jointer, with rabbeting attachments; portable electric saws; electric drills; electric grinders; endless belt sanders; and many other devices such as clamps and vises.

Water works mechanics should be furnished with: Pipe and bolt-threading machine; portable pipe-threading machine; drill press; power sewer rod and pipe cleaners; welding and cutting equipment; and a complete set of sheet-metal worker's tools.

To handle roadway equipment repairs economically, a large assortment of tools should be provided, including: Cylinder grinders; valve tools; lathes; drill presses; all types of gages and micrometers; and an electric hoist and mono-rail system.

The small paint shop should be equipped with: Portable compressors and paint spraying equipment; caulking guns; grinders, and hand tools.

All machines should be of the individual, motor-operated type, and so located that they do not interfere with the operation of any adjacent machines. There should be two portable work benches to save carrying parts back and forth from the permanent bench; thus effecting a large saving in time and money.

The storehouse should keep a close inventory of parts and materials, and be kept well stocked at all times, as a machine down for two or three weeks, waiting on parts, is not paying dividends.

The division shop should be able to work material up to 6 to 8 in., and pipe up to and including 12 in. If the car department does not have a large rip saw, or if it is not conveniently located, the bridge and building shop

should have one to enable the salvaging of second-hand bridge stringers. Old bridge stringers are generally deteriorated at the ends only, and by cutting 18 in. off each end, 8 to 10 ft. can usually be saved for ripping; the salvage being used for sleepers, sheathing, etc. If used in dry places, this material will last for years, effecting a considerable saving. Furthermore, scarce as new lumber has been in recent years, it would appear that the real shortage has only just started.

Properly equipped bridge and building shops will handle valve repairs; repairs to, and the construction of, window sash and frames, doors and frames, screens, signs and crossing gates; the construction of small buildings, such as telephone booths, toilets, switch shanties, flag shanties and tool houses; and the cutting of the framework of larger buildings for field erection, thereby facilitating and expediting their construction. Also, repairs to damaged freight shipments, as are now done by some railroads, could be made in these shops, with large savings.

Stove and furnace repairs, as handled by sheetmetal workers, including the manufacture of stovepipe and elbows, could be done much more cheaply in a company B. & B. shop, with an appreciable improvement in quality over purchased items, and, likewise, gutter and conductor pipe, as well as many other items, could be fabricated at a saving, and, of great importance, as needed.

The past five years have taught us much about the economy possible in manufacturing our own millwork. Since the majority of our older buildings do not have set standards for window and door sizes, it has been practically impossible to obtain anything from supply houses, and where the needed items were obtainable, the cost has been prohibitive. As the result of this experience, it is evident that more can be accomplished, and a sizeable saving effected, by doing much of this work with our own forces.

B. & B. shops equipped with modern machinery and tools, and manned by trained personnel, can compete with any production shop in outside industry, both as to the quantity and quality of the work done. The frequent breakdown of facilities on the railroads is constantly a matter of importance and concern, and these can be shortened considerably when proper tools and equipment are available to carry out the necessary repair work.

Time has proved that those shops with modern equipment get the better grade of workmen; workmen that are proud of the quality of work they turn out. The saying of our grandfathers, "A workman is known by his tools," is just as true today as it was in their time. The psychological effect produced by the condition and fitness of the tools and equipment with which a man works is the greatest factor in determining the quality and quantity of the work that can be expected of him.

DISCUSSION

Guy E. Martin (I.C.) mentioned that cypress and poplar lumber can be salvaged from old stations and other buildings and used by well-equipped shops for repairing damaged furniture shipments and for making office furniture for temporary offices. F. G. Campbell (E.J.&E.) agreed that company forces can turn out good quality work with such shops which will compare favorably with that of commercial shops, but he questioned whether the costs would be less. Answering this question, Chairman Davis said that costs of work done by company forces are often lower, than if it is done by others.

A. E. Bechtelheimer (C.&N.W.) wanted to know whether there were any such completely equipped shops as described in the report, a query which H. Pryor (St. L.-S.F.) answered by saying that his road had such a shop and also has outfitted four cars as mobile shops. He added that well-equipped fixed and mobile shops are helpful in attracting and holding skilled personnel.

Lee Mayfield (M.P.) touched off a live subject by announcing that, in his experience, a 1½-ton truck for bridge and building work will pay for itself in about a year, and is ideal for transporting men and for emergency use. Wilbur Lampson (Me. Cent.) questioned the advisability of having trucks of such a low tonnage rating, and after further discussion by L. H. White (I.C.), Mr. Campbell, and V. W. Hutchings (S.P.), the general consensus was that a three-ton truck is the most satisfactory.

Answering a question raised by Mr. Campbell, Chairman Davis stated that a mobile shop for bridge gangs should be equipped with a 12-tool air compressor and the necessary tools, a portable electric generator with electric drills and other appliances, and extension cords for connection with utility power

lines. He added that box cars do not make good mobile shops and that baggage cars should be used for this purpose. Mr. Pryor expressed the opinion that, in general, pneumatic equipment is most suitable for bridge gangs and electric equipment for building gangs.

Servicing Facilities for Diesel Locomotives

Committee Report

B. R. Meyers (chairman), asst. to ch. engr., C.&N.W., Chicago; L. P. Kimball (vice-chairman), engr. bldgs., B.&O., Baltimore, Md.; A. D. Reed (vice-chairman), mast. carp., C.B.&Q., McCook, Neb.; R. C. Baker, supvr. b.&b., C.&E.I., Danville, Ill.; E. H. Barnhart, div. engr., B.&O., Garrett, Ind.; G. W. Benson, supvr. b.&b., C. of Ga., Macon, Ga.; Elmore J. DeWitt, engr. b.&b., N.Y.O.&W., Middletown, N.Y.; H. M. Dick, mast. carp., Penna., Columbus, Ohio; V. E. Engman, ch. carp., C.M.St.P.&P., Savanna, Ill.; A. C. Johnson, asst. supt. b.&b., E.J.&E., Joliet, Ill.; G. E. Martin, supt. w. s., I.C., Chicago; F. H. Masters, ch. engr., E.J.&E., Joliet, Ill.; L. R. Morgan, fire prevention engr., N.Y.C., Detroit, Mich.; and J. S. Vreeland, sales representative, Simmons-Boardman Publishing Corporation, with headquarters at New York.

SINCE the first streamlined Diesel passenger train went into regular service in 1934, there has been a steady increase in the use of Diesel locomotives. On February 1, 1946, the records show the following number in service and on order:

	No. in Service	No. on Order	Total
Passenger	213	107	320
Freight	318	110	428
Pass. or freight	89	2	91
Switching	2,373	148	2,521
Total	2,993	367	3,360

The total of 3,360 represents about 8 per cent of all locomotives in the United States; and if investment is considered, the percentage is larger.

Up to the present time the maintenance of Diesel facilities has not been much of a problem because such facilities are still in the development stage and only a few have been in service long enough to require major repairs. Some roads are now making their first installation, and, if correctly designed and installed, will require minimum maintenance. This report will deal mainly with fuel, water, and sanding facilities outside of Diesel shops, as developed by those roads with considerable experience, and will present a few observations and suggestions by the committee.

Other Facilities Required

Diesel locomotives consist of one to four power units, each of which requires individual servicing. Due to the multiplicity of servicing points on each unit, the facilities for steam locomotives are not suitable for servicing Diesel locomotives and other facilities are required.

The number of locomotives to be serviced and the time available for servicing must be given full consideration in determining the type of facilities to be installed. At terminals, high speed in the servicing and quick return of locomotives to service may not be so important, and extensive facilities may not be justified where only a few locomotives are serviced. However, on the road, where time is limited, the servicing facilities provided must be adequate whether one train or several trains are to be serviced; it is usually only necessary to increase the size of storage tanks when additional trains are to be handled. This means that servicing facilities must have sufficient capacity and be maintained in such condition that complete servicing of a locomotive is finished by the time its train is inspected and the station work is done.

Regular servicing stations are usually spaced from 400 to 500 miles apart, with provision for emergency servicing at intermediate points where sufficient help will be available on short notice.

Fuel Oil

The oil used as fuel on Diesels has the following characteristics:

Free from grit, acid, fibrous or other foreign matter.

Water and sediment should not exceed 0.05 per cent.

Pour point not higher than minus 10 deg. F.

Gravity 30 to 40 deg. A.P.I.

Viscosity 35 to 45 sec. at 100 deg. F.

Ignition quality should have Cetane rating of not less than 50.

Greater percentage will distill under 650 deg. F.

Flash point above 150 deg. F.

It is important to have adequate storage facilities, and tanks should hold minimum requirements and have capacity to unload a full tank car. Some roads require storage capacity sufficient for a week's supply to guard against interruptions in delivery. Storage tanks should be as close to service outlets as possible to minimize pipe friction. It is desirable that they be placed above ground to permit ready inspection and periodic painting. They should have dikes around them with a capacity of 1½ times that of the tanks to confine the oil in case of leakage. Where law requires that storage tanks be under ground, they should be placed in pits large enough to permit proper inspection and maintenance. They should be properly anchored if subject to hydrostatic pressure, and should be grounded to protect them against static electricity. All tanks should be equipped with manholes and with adequate size vents with flame arresters, and should provide for cleaning and flushing. Consideration should be given to the installation of two tanks connected up so that either can be used independently. This permits repairs to be made to one without disrupting service. Except on large-capacity high tanks, the intake and discharge pipes should enter at the top to eliminate loss of oil in case of pipe breakage.

Diesel fuel oil flows freely in cold weather and heating is unnecessary. Booster pumps are used in most cases to insure adequate flow; and since a large gravity head is not required, the storage tanks are usually placed on low cradles just above the ground level. Where multiple power units are serviced, there should be an outlet for each unit, with the various outlets so spaced that all units can be serviced at one time or without respotting the locomotive. This is more satisfactory than having one outlet and using a long length of hose. To keep the length of hose to a minimum, some installations in terminals have riser pipes adjacent to the track, extending to a height of about 9 ft., with swing connection for the hose. However, on the road, it is the usual practice to have each outlet in a pit of sufficient size to accommodate 20 to 25 ft. of hose. These hose pits are usually made of concrete, properly drained and equipped with quick-opening covers, flush with the ground. A long, narrow box permits the hose to be laid out straight, and the use of a lighter weight cover, which can be in sections. False slot bottoms in the pits will keep the hose away from water and dampness and thus prolong their service life.

Fuel oil lines on the road are usually 3-in., and the hose used with them is 2½ in., equipped with connections for coupling direct to locomotives. Pipe of larger size may be required where long lines cause large friction head losses or where a very high rate of delivery is required. Plug-type valves, the same size as the hose, are used with an expansion-ring type coupling with a pin lug. Shank-type couplings may be used but this type sets up more friction. Some roads prefer trigger nozzles. The hose should be wire reinforced and grounded. One road reports that it has cut down maintenance by eliminating the use of flexible hose and the use instead of 2-in. pipe with flexible mechanical couplers similar to a pantograph.

Pumps should be electrically driven and should have a capacity of 300 gal. per min. or more at road points; they may have a smaller capacity at terminals, depending upon the time element and the number of units to be serviced. Modern pumps have built-in by-passes to absorb surges caused by quick-acting valves. A home-made by-pass can be made easily by using a pressure-relief valve with a pipe connection back to the supply line. At important road servicing points, it is desirable to have dual pump installations for protection.

In lieu of a booster pump, installations for switchers have been made by introducing air pressure into storage tanks by means of a small motor-driven compressor.

The road Diesel unit has a capacity of about 1200 gal. for the 1,500-hp. size, and up to 3500 gal. for the 3,000-hp. size, and can usually be serviced from both sides. Switchers hold about 650 gal., depending upon their size, and are usually serviced at some convenient opening at the rear platform.

A fireproof house should be provided for pumps and valves. Wiring should be of approved type and the motors of the non-explosive or vapor-proof type. Switch controls for pumps should be at delivery points.

Filters should be installed to insure that no foreign matter in the oil is delivered to the locomotive tanks. Extreme care is also needed to guard against dirt getting on hose coupling and thence into the tanks.

Where joint facilities are maintained, it is necessary to have a meter to insure correct billing. A meter or tank gage is desirable in all installations to obtain a record of oil unloaded or dispersed. Many recent installations provide concrete box conduits with removable covers for all pipe lines to provide easy access for inspection and maintenance.

Water

Diesel locomotives require less water than steam locomotives, although the requirements as to quality are more exacting. Engine cooling systems hold from 100 to 600 gal., and if all connections are kept tight they will not require filling except at terminals where hydrants can be conveniently located. In case the pressure is very low, a large size hose may be required. Hydrants should be as close to the servicing point as possible to keep the hose to a minimum.

Water satisfactory for steam locomotives is usually not pure enough for use in Diesel cooling systems. It is recognized that distilled water, or its equivalent, must be provided for this use to prevent trouble on the road and to eliminate expensive maintenance to the units. Proper treatment must prepare the water for many temperature changes in the cooling cycle, in order not to damage the various metals and materials with which it comes in contact. Even when distilled or demineralized water is furnished, an inhibitor is usually added to prevent corrosion, as it is very important that no rust or scale deposits be permitted in the cooling system.

Many roads use water which has been treated for steam locomotives, and further treat the water by additives placed in the cooling system. While this method has been more or less satisfactory, it is pointed out that leakage in the cooling system may result in incorrect treatment; and it is felt that a better arrangement is to have a cooling water storage tank at supply points, equipped with necessary treating and testing equipment, so that correct treatment can be insured before water is placed in the cooling system. Some roads have set up equipment to furnish distilled water for use in cooling systems, which is supplemented with a chromate or other suitable treatment that may be required.

One western road has installed a water evaporating plant consisting of a three-unit evaporator with capacity for producing 20,000 gal. of distilled water per day. Steam from the terminal boiler plant furnishes heat for the plant, and the entire operation is automatic, including the mixing of a soluble oil with the distilled water to make it non-corrosive.

Diesel passenger locomotives are equipped with generators to furnish steam to the train steam line. The water storage capacity for steam generator supply varies from 1,000 to 2,500 gal. The amount of water consumed varies with the number of generators in the locomotive, the number of cars on the train, and the outside temperature. Water used in these generators requires very careful treatment to keep the generator coils free from scale and corrosion. The maximum consumption of water per generator is about 170 gal. per hour for small generators and up to 340 gal. per hour for the large type.

The heating plants of Diesel locomotives should require filling only at points where fuel oil is taken, except in extreme cold weather when it may be necessary to call on intermediate points. These intermediate points should be at scheduled stops and the servicing equipment provided should be of ample capacity to avoid delays. This will usually require 2-in. or 2½-in. hydrants and connecting hose, with pipe lines and pressures sufficient to deliver 300 to 400 gal. per min. If booster pumps are required, they should be automatic in operation or have switch control at the hose outlet. Separate storage tanks for steam generator water supply appears desirable, where the water can be treated with a combination phosphate-tannin or some other suitable treatment before delivery to locomotives.

Servicing outlets for water should be located so that water can be delivered to the cooling and generator storage tanks at the same time locomotives are taking on fuel oil.

Sand

Sand used for steam locomotives has been found satisfactory for Diesel use; however, more extensive facilities are needed to deliver it to the sandboxes of Diesels. Sand should not be put into Diesels with compressed air, as dust should be avoided as much as possible. An overhead storage tank with

gravity feed is the recommended practice.

A road Diesel unit has a sandbox at each corner, with service openings on the sides of the locomotive about 8 ft. above the rails. Each sandbox holds from 4 to 10 cu. ft. There are no windows or gages on these sandboxes to indicate the level of the sand; therefore, the valve should be located in the delivery line as close as possible to the discharge end to minimize the spilling of sand. These sandbox openings do not require special fitting, so any type of nozzle may be used which will enter the openings.

Minimum sanding facilities for road Diesels consist of an overhead storage tank of sufficient capacity for one locomotive, with a delivery spout on each side so the two sandboxes opposite each other can be filled at one time. On a four-unit locomotive, this arrangement requires spotting the locomotive eight times. If hose of sufficient length is used on the ends of the delivery pipes, the end boxes in adjacent units can be filled at one spotting, thus requiring only five spots for a four-unit locomotive.

Several manufacturers of railroad sanding facilities have designed systems which deliver sand to all four boxes on a unit at one time. This requires a higher elevation for the sand storage bin, or a separate bin over each set of spouts. Any number of these units may be set up in a row at the proper spacing to service several units at one spotting. One design on the market consists of an overhead storage bin holding about ten tons of sand, which is hung on a monorail over the center of the servicing track. Suspended from the tank is a delivery spout with a suitable length of hose for each side. The monorail unit is moved by an electric motor controlled by rope pulls along one side of the track. The monorail is long enough so that one locomotive can be serviced without respotting. The storage bin is spotted in a central location when not in use, where a discharge pipe replenishes its supply.

Road Diesels need sand servicing only at the terminals of their runs, and thorough study should be made before extensive facilities are installed to insure that the expense can be justified.

Sand delivery spouts and hose should be a minimum of 3 in. in diameter and should be fitted with moisture-proof valves. To insure proper delivery, the spouts should have a slope of not less than 35 deg. with the horizontal. Wrought iron pipe is used by many roads for sand piping. When turns are necessary, a 45-deg. "Y" is used, with the straight leg capped. This permits the straight leg to be filled with sand and reduces considerably the wearing of the metal in the turn. There is, also, excessive metal wear just beyond the turn, and it is suggested that a flanged pipe about 18 in. long be installed in the line at this point to provide for easy replacement, and to keep the amount of pipe replaced to the actual excessive wear area.

The sand openings of Diesel switchers vary from 4 ft. 4 in. to 12 ft. 6 in. above top of rail and are found on the tops, sides and ends of various type units, requiring the use of flexible hose to service all of the particular types that may be in service at any one terminal. It is unfortunate that the sandbox openings on all Diesels have not been standardized, so they can be filled from the top of the units; and thus considerably simplify the required sanding facilities.

Most towers and storage bins are of steel construction, although some roads have used wood. The present trend is to provide for dry sand storage in new coaling stations; and some roads have designated a track at some coaling plants for Diesel sanding.

In considering a new separate facility for sanding Diesels, thought should be given to the hauling of dry sand from an existing drying plant, and thus eliminate the necessity for constructing additional sand-drying facilities. This would require only a small hopper to receive the sand, which could then be elevated to the storage tank.

Fire Hazard

Diesel locomotives present more of a fire hazard than is generally realized. Oil, dust, paper, etc., are picked up while running and accumulate on trucks, traction motors, fuel tanks, and other parts under the floor, setting up conditions where fires are easily started. Many fires have been started by sparks from brake shoes. Smoking and the use of open flames should be prohibited around Diesel fueling stations, and every precaution should be taken to prevent oil leakage. A thoroughly satisfactory system of fire-fighting apparatus for road protection has not, as yet, been adopted, but many roads have provided facilities for this purpose. A water hose with fog nozzle can easily be provided at road

servicing points for fire-fighting purposes.

Diesel locomotive servicing facilities are very important and must be inspected regularly. We must see that they are in good condition at all times to do our part in keeping today's high-speed trains on schedule.

DISCUSSION

After a member had inquired about fire-protection appliances on Diesel locomotives, L. R. Morgan (N.Y.C.) stated that, so far, no definite steps had been taken by the Association of American Railroads for fire protection on these locomotives, although several committee meetings have been held and suggestions noted. He added that the limited space available on these locomotives precludes the possibility of using any bulky equipment. One of the suggestions advanced by an A.A.R. committee, he said, is to have two 50-lb. carbon dioxide extinguishers and 50 ft. of hose on each unit, supplemented by a small container of carbon tetrachloride, but he cautioned that the latter extinguisher causes a toxic gas and must be used with extreme care, and by operators who have been instructed in its use.

Methods of Cleaning Water Lines, Sewers and Drains

Committee Report

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WATER main and sewer cleaning has been done to some extent by the railroads for many years using various methods and with varying results. The need for such work has been accentuated in the past few years. Prior to the war, the necessity for effecting economies in operation prompted investigations which revealed that at many points high operating costs were the result of pumping water against high pressures created by obstructed pipe lines. Also during that time many railroads inaugurated high-speed passenger and freight runs which involved schedules that required taking water with minimum delay. This, in many cases, suggested the cleaning of crane lines to permit maximum flow.

During the war, with greatly increased traffic, water requirements for motives and other purposes severely taxed the capacity of many plants. The scarcity of labor and materials made it mandatory in most cases to continue operation with existing facilities. This condition, among other things, necessitated obtaining increased capacity from existing pipe lines, and in many instances this was done by cleaning them.

In recent years improved methods of cleaning both water and sewer lines have been developed and several companies are now engaged in this type of work. The assignment of this committee was to review the various methods and this report indicates the result of our findings. It is divided in two parts; the first covering water lines, and the second sewers and drains.

Causes for Cleaning

The need for cleaning pipe lines is generally obvious. All water service men are familiar with formulae from which the operating pressure which should prevail under any given pumping condition can be determined readily. If this pressure is exceeded to any great extent, it is apparent that there is an obstruction in the line.

A large percentage of the obstructions found are due to after-precipitation of lime and other mineral salts carried over from lime-soda treating plants, or as a result of reaction in pipe lines from treatment with soda ash or other re-agents in the absence of adequate settling or storage capacity to permit the reaction to be completed before the pipe line is

reached. The hardness of these precipitates varies greatly with the mineral content of the water used, and is likely to be very hard.

Other causes of obstruction in pipe lines are silting where a muddy supply is used, tuberculation and a deposit of the iron bacteria Crenothrix, which is present in many well waters, particularly in the Missouri River valley.

Reports of recent cleaning operations show that many other obstructions, including large chunks of lead, pump valves and springs, pieces of wood, shovels, partially closed and hidden valves, are found. Hot water filling systems in enginehouses are particularly susceptible to rapid incrustation due to the precipitation of lime and other minerals in the presence of heat.

Methods of Cleaning

In general, the methods of cleaning in use are classed as hydraulic, mechanical and chemical. The hydraulic method involves the use of a tool consisting of a series of flexible cups attached to a hollow stem, to which are also attached a group of cutting plows that are held firmly against the incrusted material by powerful springs. Water pressure from the rear against the cups propels the tool and the flow of water through the hollow stem, with a nozzle effect at the end, washes the dislodged material ahead and out an opening in the pipe. This tool has been developed to operate in all sizes of pipe, from 4 in. to 60 in., and will execute 90-deg. bends.

Mechanical cleaning uses a tool with various types of cutting edges or plows, which is pulled through the pipe by a cable operated by winch, or it is propelled forward by a flexible shaft driven by a gasoline engine or electric motor.

In both hydraulic and mechanical cleaning, the tools are inserted in the line through openings which are prepared by cutting out a section of the pipe and inserting Dresser-type couplings to permit re-use of the section removed and rapid re-assembly of the line. Occasionally, both the hydraulic and mechanical methods are used to clean riser pipes into tanks, pumps or water cranes.

Chemical cleaning is done by circulating acid, usually muriatic, inhibited or otherwise, through the lines to be cleaned, the purpose being to dissolve the incrustation by reaction of the acid with the mineral salts present. The acid is usually pumped from a receptacle to one end of the line, thence through the pipe line and returned to the receptacle where its strength can be checked to determine when the reaction has been completed, and additional acid added as required.

Some examples of the effective cleaning of water lines reported are given in the following:

At an important engine terminal where the daily consumption of water was about equal to what could be pumped in 24 hr. continuous operation, 4,500 lin. ft. of 12-in. water main leading from the treating plant to the various service tanks was cleaned hydraulically. The line was out of service for about 1½ hr. while each of the two cuts were being made to permit entrance and exit of the tool, which traversed the full 4,500 ft. in 21 min. Several tons of mud and scale, and a shovel, were taken from the line. The delivery capacity of the pumps in the treating plant, by reduction in operating head, was increased by 300,000 gal. daily, and the electric current consumption for the average delivery of water was reduced by about 400 kw. hr. per day at 1¼ cents per kw. hr.

At an intermediate watering point, delivery from a 50,000-gal. elevated storage tank through a short run of 12-in. pipe to a 10-in. water crane had been reduced to the point that 15 to 20 min. were needed to water a locomotive. The line was found to contain about 5 in. of incrustation and was cleaned mechanically. A metal strainer, practically the same diameter as that of the 12-in. pipe, and with all holes nearly plugged solid, was encountered in the pipe. After cleaning, 4 min. and 9 sec. were required to put 10,000 gal. of water into a locomotive tender.

At another terminal frequent complaints had been received about slow equalization of water between the various tanks in the yard and the slow delivery of water to locomotives at the passenger station. Approximately 5,500 ft. of 8-in. line containing 3 in. of incrustation was cleaned by a combination hydraulic and mechanical process. In the operation, a partially closed 8-in. gate valve not of record and buried under a concrete platform was located and dug out. The position of this valve was the primary reason for slow delivery of water to locomotives.

Most railroad drainage systems are laid with salt-glazed tile, although concrete or cast iron pipe and brick are used to some extent.

Much of the necessity for cleaning these sewer and drain lines appears to be the result of the deposit of cinders, earth and other materials washed in from cinder pits, roundhouses and turntable pits, or through open manholes in surface drainage systems.

Also, frequently where highly mineralized water, such as drainage from locomotive or power-plant blow-down systems, enters sewers, the minerals are deposited, usually forming a very hard incrustation in the pipe. Drainage from oil cellars, engine washing platforms or other facilities where waste oil is present, forms deposits which are troublesome. Tree roots and other growth are sometimes found.

Various types of cleaning devices are used in sewer work, including the old reliable plumber's rodding tape often used to open small domestic sewers which have become clogged. Also for small pipe work, a power cutter operating from a flexible shaft and driven by an electric motor is used. This type of instrument can be equipped with cutters which will remove hard deposits, tree roots, etc.

When sewers of 6-in. diameter and larger, and of any considerable length, are involved, the most practicable and sure method of cleaning seems to be the arrangement whereby buckets or scoops are pulled through the line. Starting with one of small diameter and ending with one just slightly smaller than the internal diameter of the sewer, these buckets, attached to a wire cable, are drawn through the line by winches, one located at a forward manhole and the other at the rear for pull-back purposes. The dislodged material is carried to the surface of the rear manhole where it can be disposed of independently of the sewer system. Distances up to several hundred feet are cleaned with one setting of the winches. Where the material encountered is heavy and compacted, a series of pointed bars comprising a slitter is pulled through the sewer ahead of the buckets.

Examples

Among the interesting experiences of sewer cleaning reported is that at one engine terminal where all of the facilities, including a 30-stall enginehouse, turntable, boiler washing plant, and two mechanical cinder-handling plants, were connected by laterals of various sizes to the general disposal drain, which consisted of about 2,500 ft. of 18-in. and 24-in. tile and concrete pipe. When examined, this drain was found to have not more than 8 in. of open space at the top, and in some places only 4 in. was open for flow. Every time it rained, water backed up into the turntable, enginehouse pits and other facilities, resulting in great inconvenience to operations. Much time and effort were expended in attempting to keep this drain open.

It was finally decided to clean the line by the bucket method described, and many cubic yards of accumulated debris, including mud, cinders, sticks, pieces of pipe, and large pieces of lime formation from the boiler-washing plant drain, were removed. The formation was so hard that it was frequently necessary to use a slitter to loosen it. It is reported that this line was cleaned for a fraction of the cost of replacing it, a procedure that would have soon been necessary if it could not have been cleaned.

Summary

It is the conclusion of this committee that the expense of water pipe and sewer cleaning can in most cases be justified by savings in the cost of pumping water, in the time required to water locomotives, and by reducing maintenance expenses around terminals and other points caused by the necessity for repeated opening of sewers and by necessary repairs occasioned by damage resulting from flooded conditions due to clogged sewers.

It is further concluded that the only assurance that a pipe line is thoroughly cleaned and not partially closed by a hidden valve or other obstruction, is to pass a tool or other object through it, as near in size as possible to the internal diameter of the pipe that is being examined.

It is also the opinion of the committee that where smaller lines, with complicated branch lines from feedwater heaters and blow-down, washout and filling systems in enginehouses, are involved, the cleaning can be done to better advantage by the acid method.

DISCUSSION

In a brief discussion following the presentation of this report, all of which reflected the value of cleaning fouled pipe lines and sewers, G. W. Benson (C. of Ga.), pointed out that the results achieved are sometimes no less than amazing. In this connection, he said that, following the clean-

ing of 16,000 lin. ft. of water line at a terminal, the pump performance was so improved that he was asked by one not informed concerning the cleaning work what accounted for the amazing improvement in pump performance that had occurred.

Chairman Gibson commented upon the fact that, because of the difficulty of procuring pipe, the cleaning of the existing lines has become of greater importance today than ever before, as it may often preclude the necessity of laying new lines.

Developments in the Use of Off-Track Equipment

Report of Committee

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A YEAR ago we were all animated with enthusiasm by the successful termination of the struggle in which we and our allies had been engaged for the last four years. It seemed that the period ahead would be much more productive of permanent improvements in our properties and facilities than had been possible during the war years.

Unfortunately, this was not to be. Progress has, of course, been made, and extensive renewals and improvements have been completed. The difficulties that have faced us, however, have been as great or greater than those during the war years. Materials in many cases have been even more difficult to obtain. Restrictions on general building construction, for the avowed purpose of providing homes for veterans, has produced utter confusion. If these restrictions had accomplished their purpose, we would have no quarrel with their protagonists. It is painfully apparent, however, that they have not and will not accomplish that purpose.

Labor troubles and strikes have contributed their full share to the chaos of material supply. In the case of many materials, it is impossible to obtain commitments as to delivery dates. In many instances a delivery date means simply a date to start following up the order, with no real indication of when the material will be received.

The situation with respect to work equipment, at least in so far as actual deliveries are concerned, is in many instances worse than that of general construction material. The manufacturers have done and are doing everything in their power, but are dependent on suppliers who are, in turn, dependent on the whims of irresponsible labor leaders.

Much Unproductive Labor

During the last year, we in the bridge and building department, together with those in other departments of the railroad, have experienced labor troubles. A large increase in direct wages has increased the cost of doing our work. Recent legislation as to pensions and unemployment compensation will increase the indirect labor charges considerably.

These increases in labor costs point to the necessity of so planning our work that the labor costs under our control are kept to the absolute minimum, and still permit the accomplishment of the results desired by our managements.

The labor costs under our control consist of two general parts. One of these includes the cost of labor actually engaged in productive work on any project. To keep this at the minimum requires that we make, so far as possible, each man the operator of a machine or tool. The day of a strong back and a weak brain in B.&B. crews is gone.

The second part of our labor costs is the non-productive labor charges for operating crews for the protection of our work equipment when on the track. So long as track-mounted work

equipment is used, this will be encountered. The labor organizations representing these men are powerful and grasping. Pressure is increasing to require operating crews on all equipment operated on the track. In many cases this has already resulted in increases in the number of men required beyond the needs of safety for the operation of trains. For example, on many railroads, a locomotive fireman or engineer is required on each locomotive crane, in addition to the crane operator. This provides an extra job for no work performed.

The only way this unnecessary overhead expense can be avoided is to get our equipment off the rails and keep it off. This has the important additional advantage of minimizing delays to trains.

Great care and careful planning are required to insure that off-track work equipment is used in such a manner as to avoid the possibility of claims from operating employees that they be allowed to furnish protection for the passage of trains. It is true that, in many cases, this cannot be avoided, but careful planning and forethought can keep such demands to a minimum.

Highway Motor Equipment

The cornerstone upon which our structure of off-track construction and maintenance must be built is the highway motor truck. The development in trucks for war use was no less than phenomenal, and we should reap the benefits in the next few years.

Before the war, for all practical purposes, the highway motor truck was confined to a hard-surface road. With the more complete development of four-wheel drives, the mobility of trucks is practically unlimited. With the exception of deep mud or thick forests, modern heavy-duty trucks can go almost anywhere. Even these obstacles can be overcome by cutting roadways through forest growths and by corduroying swampy ground.

For a large job, even a considerable investment in providing a temporary road will be more than offset by the savings in work-train expense and reduced delays to trains and interruptions to the work. By suitable negotiations with land-owners, permission to build such temporary roads can generally be obtained, as in most cases they enhance the value of the land to the owner. With modern bulldozers, equipped with rooters, etc., and other suitable earth-moving equipment, the expense of such temporary roads is not excessive.

With an access road available for the use of motor trucks, there are a number of methods of conveying equipment to the job. The choice depends largely on the size and weight of the equipment.

Small and light equipment can be carried in the trucks, or towed behind them, if equipped with pneumatic tires. Medium-size equipment can be moved on a trailer, pulled by a general-purpose truck. An interesting development in trailers for this purpose is a two-wheel trailer, which is made self-loading by the long end of the body forming a ramp, which is later lifted for attachment to the truck; the equipment being balanced over the axle.

The heavier units of work equipment can be handled on special low-body trailers pulled by truck tractors. Such hauling equipment will not ordinarily be owned by the railroads, but can be rented as required from concerns specializing in the transportation of heavy equipment.

On the job itself, hand labor should be kept to the minimum by the use of power tools. Developments in these tools have been many and of great interest. They are, however, outside the scope of this report. On the other hand, the source of power for operating such tools does fall within the scope of this report.

Power Supply for Tools

Until a few years ago, and even at present to the extent that it has not been replaced by more suitable equipment, the conventional source of power for the operation of power tools was a compressor, either track mounted or skid mounted. In any case, the compressor was set off at one location and, ordinarily, was not moved during the progress of the work. If the job was large, with any sizeable number of air tools in operation, the compressor was large and heavy, and the cost of getting it to and from the job was excessive.

At present, even large compressors can be had mounted on pneumatic tires, and can be readily towed to the job. However, the most pronounced and beneficial development in power units is the trend toward small, readily-movable units. In most cases, experience has shown that it is better and more economical to have several small power units placed where needed. Where this practice is followed, the failure of a single unit does not cripple the job until it can be replaced or repaired. Where a single large unit is employed, failure could com-

pletely tie up the job. An even greater advantage in the use of several small units is the elimination of the long pipe lines frequently necessary in the past where single large units have been used. The small units can be placed where needed, and moved from time to time as required.

The power units now in use include both air compressors and electric generators of many types and makes. All have been modified and improved extensively during the war years to meet the need of the construction forces of the army and navy.

Due to the types of specially adapted tools available for use with them, air compressors are essential on jobs involving the drilling or breaking of masonry, the driving of rivets, and general steel erection and repairs. They are equally satisfactory for general work and for timber fabrication and erection. Preferably, several small units should be used, with the largest capable of providing ample air for such heavy-demand tools as rivet busters or large rock drills.

For working in timber, electric tools have some advantages, among which are their light weight, and the greater ease of handling an extension cord than an air hose. Since on many jobs it is necessary to progress work at night to avoid interference with trains, generators may be necessary in any event for providing illumination.

For small jobs requiring few tools, the generator may be light enough to be carried by one man. The most generally useful unit, however, is one of medium weight which can be carried by a few men or wheeled on rubber tires. This is the same type unit used by track forces to operate tie tampers. If used by the track forces, the adoption of this type by the B.&B. forces has the advantage of reducing the number of repair parts to be stocked. Generators larger than this should, ordinarily, not be considered, as their reduced mobility is objectionable.

Beyond the power supplies for the operation of tools on the job, the greatest field for work equipment in bridge and building work is in the handling of materials. In the past, many jobs requiring the handling of heavy materials have been done by brute strength alone because the job as a whole did not warrant the expense of work-train service to provide cranes or hoists.

There are now available a number of types of power hoists which make this expensive use of manual labor archaic. Perhaps the most generally useful of these is an air hoist operated by a portable compressor. With such a hoist and gin poles and suitable rigging, heavy timbers can be placed in overhead or track bridges, piles can be cut off and spliced, timber bents renewed, repair steel erected, and many other types of work performed with little hand lifting. Similar electric hoists are available and several types of trucks have hoists operated by power take-offs. For making renewals of individual members of a structure, careful consideration should be given to the use of one or more of these types of hoists before considering more elaborate hoisting equipment.

Before the development of modern heavy-duty, track-mounted locomotive cranes and derrick cars, a large amount of railroad construction was performed by the use of guy derricks. These were operated by steam engines requiring in each case a cumbersome boiler and an adequate water supply. With modern gasoline hoisting engines now available and the considerable development that has taken place in these guy derricks, it would seem that, in some instances at least, these would be of value. We mention this in passing as a line of investigation for individual members, particularly in light of the fact that one large bridge has been erected recently by such equipment.

The most generally useful device for lifting material where the weight is not too great is the highway motor-truck crane. This has seen great development during the last few years. Such cranes can be obtained in many types. Heavy-duty cranes of this type can be had with long booms and capable of handling heavy loads. Their value is greatly enhanced by their extreme mobility. Such a crane need be brought to the job only for the period that heavy lifts are to be made. At other times it can be moved readily to other jobs or used for other types of work.

A variation of the highway motor-truck crane is the wheeled tractor crane. This has been developed primarily for the handling of freight or cargo at freight terminals and yards, or on piers and wharves. However, where a railroad has such cranes, they can be used to advantage on many construction jobs. Such tractor cranes, developed during the war, are of greater capacity and usefulness than those available only a few years ago.

For heavier lifts, or for jobs where cranes will be used for a considerable period, crawler-type cranes are generally more suitable than truck cranes. Modern types of crawler cranes move

much more rapidly than those built a few years ago. They can be used on rough ground and under other conditions where a truck crane is not suitable. By placing planks on the ties of open-deck bridges, outside the running rails, they can be used readily on the decks of such bridges. Furthermore, they can be moved off such bridges, and off the tracks in the clear for the passage of trains, in less time than a track-mounted crane in a work train, unless a special construction track has been built for it at the site. In most cases it will cost less to obtain access to the job for off-track equipment than to build such a construction track.

Off-track cranes can do most of the work expected from track-mounted cranes, and even much that can be done by track-mounted pile drivers. It is true that for some railroads having large numbers of long pile trestles, the possession of a special pile-driving rig is still essential. However, for the smaller pile bridges making up the vast majority of those we deal with, a crawler crane equipped with swinging leads is a much more productive investment.

Power for the pile driving hammer is ordinarily furnished by a portable steam boiler. Piles can be driven successfully by compressed air if sufficient compressor capacity is assured, and preferably if the air is manifolded into a large air reservoir to reduce the drop in pressure when the hammer is working. In cool or damp weather, the use of alcohol in the air line is advisable to avoid the formation of ice in the hammer.

A further factor to be considered in the use of off-track equipment is the possible redesign of structures to reduce the necessity for interference with traffic. A notable example of the possibilities in this respect is seen in the work of one road which recently replaced an important timber pile structure, using fluted steel piles, driven in sections from beneath the deck with off-track equipment. The only interference with traffic during this job was during the actual installation of the new deck.

A variation of the crawler-type crane is the crawler tractor equipped with boom and hoist, developed only during the last few years. A major use of this type equipment has been in the construction of cross-country oil and gas pipe lines. In addition to its use on pipe-laying jobs on the railroads, this type equipment should prove of value for a wide range of miscellaneous construction.

An interesting development in connection with crawler tractors is that of track-walking shoes, which can be applied to any tractor of proper size to permit it to travel on the rails. While this development is of primary interest to the track supervisors, a tractor with boom and hoist, equipped with such track-walking shoes, may well be the answer to the problem of providing off-track hoisting equipment at many points difficult of access from highways.

When we turn to B.&B. activities other than the repair and construction of bridges, it is apparent that off-track equipment is the only thing to consider. These other activities lie almost entirely within the scope of the general construction industry, for which most off-track equipment has been specifically developed. The same equipment which we consider desirable for bridge work—namely, light, portable compressors and generators, truck cranes and crawler cranes—is likewise best suited for our general work.

Modern highway truck cranes and crawler cranes are equipped with accessories to operate as power shovels, ditch hoes, bucket excavators, etc., as well as hoisting units. Such equipment is ordinarily of greater interest to the track forces, but properly selected, such equipment can satisfactorily meet the needs of the bridge and building department as well.

It is apparent from the newer types of equipment being produced that much greater thought is going into its design. This is the basic essential in any off-track machine. If we choose a correctly designed machine and maintain it properly, we can get back our investment. Therefore, it is our feeling that the most careful thought should be applied to the choice of the design to be adopted. We should, so far as possible, avoid the choice of a design which has limited use. A good design with proper appliances, which will meet most nearly the needs of all concerned over a period of years, is the best investment.

In the final analysis, the effective use of off-track equipment is just one part of the general endeavor of all railroad employees—to move the most passengers and the most freight with the least expenditure. To attain this goal, all phases of our efforts must be properly balanced. The design of structures must be adequate but not excessive, and must be adapted to those methods of construction and repair that will prove most effective in the final accomplishment of our purpose.

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	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	F. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

* On the St. Louis Division, B & O R R

THE STORY OF THIS PRESSURE-TREATED BRIDGE* MAY SAVE THOUSANDS OF DOLLARS FOR YOU

Every engineer who is thinking in terms of permanent, economical construction can get some food for profitable thought from the history of this 500-foot railroad bridge.

It was built in 1910, with 5 to 6 red oak piles per bent, and with a yellow pine deck. All material was pressure-treared with creosote.

In 1930 a mainrenance engineer inspecred the structure and found it in perfect condition. He predicted a useful life of 40 years, and on a straight-line basis estimated the total interest charges and amortization as $1910 per year. In a similar structure, built of other materials, the interest charges alone—assuming perpetual life, and no maintenance—were $3750 per year, almost TWICE the cost of the pressure-treated wood structure.

According to a 1944 engineering report, it was "only wirhin the last five years that any serious deterioration has occurred, and only within the last two years that any considerable amount of renewals were necessary." It was stated that "the structure is still in fair condition and should not require any large expenditures for renewals or replacement for anorher 5 years." This will bring its age to 39. Even if the bridge had been totally replaced in 1940, so that only a *30-year* life had been realized, the yearly interest and amortization charges would have amounted, on a straight-line basis, to only $2100 a year . . . a saving of almost $50,000 for the period.

Today's mounting costs make it more important than ever to avoid repairs and maintenance by building for maximum durability. Our bulletin will give you a picture-story of a few of many applications where pressure-treated wood is cutting construction time, costs, and maintenance. Ask for "Economical and Permanent Construcrion with Pressure-Treated Wood."

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KOPPERS

PRESSURE-TREATED WOOD

KOPPERS COMPANY, INC.

KOPPERS BUILDING, PITTSBURGH 19, PA.

	1923-1924	1924-1925	1925-1926	1926-1927
President.....	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres....	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres....	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres....	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President.....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres....	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres....	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres....	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres....	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President.....	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres....	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres....	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres....	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres....	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President.....	Armstrong Chinn	A.E.Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres....	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres....	A.E.Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres....	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres....	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.....	C. A. Lichty	C. A. Lichty		
Secretary.....	.....	.....	F. O. Whiteman	A. G. Shaver
Treasurer.....	.....	.....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

FOR A LONGER-LASTING PAINT JOB
Specify Flame-Cleaning

Thorough cleaning and drying of steel surfaces is assured when Oxweld's flame-cleaning method is used. In this procedure, high-temperature oxy-acetylene flames are passed over the work, dislodging dirt and soot, evaporating all moisture, and causing scale and rust to expand and pop off. The surface is then wire-brushed and painted while warm. This provides a more lasting paint job than when other metal-cleaning methods are used, for paint bonds tighter, spreads more evenly, and dries more quickly when applied to warm, dry metal.

The ease of applying Oxweld's flame-cleaning . . . plus the high quality of the results obtained . . . have led to the use of this method to clean and dry all types of structural steelwork — train sheds, bridges, pipe, tanks, rail that is to be covered, and rolling stock of all kinds. Ask an Oxweld representative for information regarding a demonstration.

THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

Carbide and Carbon Building
Chicago and New York

OXWELD RAILROAD SERVICE

SINCE 1912—THE COMPLETE OXY-ACETYLENE SERVICE FOR AMERICAN RAILROADS

	1942-1943	1943-1944	1944-1945	1945-1946
President.....	G. S. Crites	I. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres....	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres....	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres....	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres....	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary.....	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

†To November 1, 1942
‡To February 1, 1943

—Before Repainting

The finest paint won't last long when applied to rusty, scaly steel. Little wonder that so many railroad men prepare metal surfaces by Airco Flame Cleaning before they paint. This flexible process removes rust and scale. It dehydrates as it cleans, leaving a warm, dry surface conducive to a long-lasting paint job. Write for full details.

AIR REDUCTION AIRCO

General Offices:
60 EAST 42nd STREET, NEW YORK, N. Y.

SERVING RAILROADS FROM COAST TO COAST

Avenarius Carbolineum

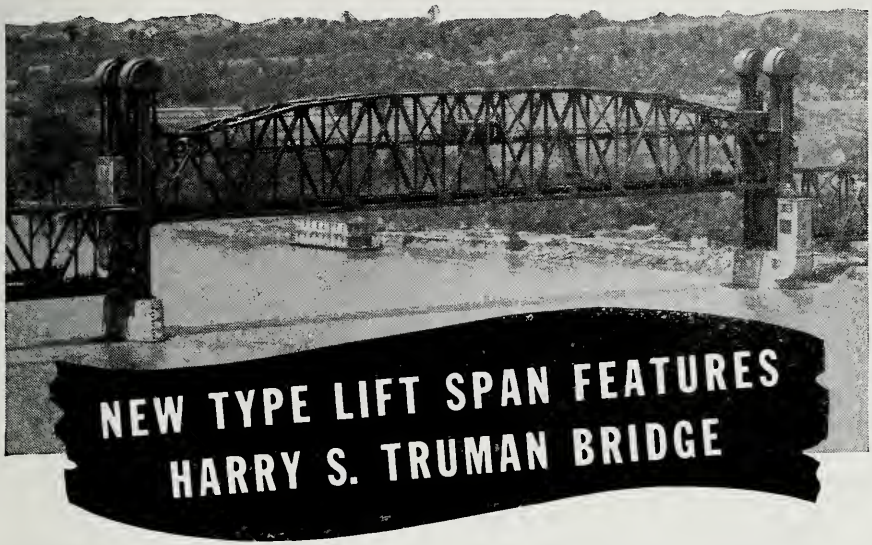
AVENARIUS TRADE MARK CARBOLINEUM

Wood Preservative

For bridge timbers - ties - platforms - poles - fences.
Applied at the job by brush, spray or dip.
No heating - no special equipment needed.

Carbolineum Wood Preserving Co., Milwaukee 3, Wis.

THE 1,600-TON, 420-foot long lift span in its raised position provides a channel width of 400 feet and a vertical clearance above low water of 70 feet for navigation. The bridge consists of three 250-ft. through truss spans, one 420-ft. through truss vertical lift span, 18 deck plate girder spans of 78 feet and one plate girder span of 45 feet. It was designed and the construction supervised by Howard, Needles, Tammen & Bergendoff, consulting engineers.



NEW TYPE LIFT SPAN FEATURES HARRY S. TRUMAN BRIDGE

THE HARRY S. TRUMAN BRIDGE crossing the Missouri River at Kansas City, Mo., is the major element of an outstanding railroad relocation project. Undertaken jointly by the Chicago, Milwaukee, St. Paul & Pacific Railroad Company and the Chicago, Rock Island & Pacific Railway Company, it provides a more direct routing of rail traffic through Kansas City, and permits faster-scheduled operations to the West Coast.

This imposing bridge is a single track structure with a total length of 2,633 feet. Its dominating 420-foot vertical lift span over the navigation channel is electrically operated by remote control from a 3-story operating house located on one of the end piers. A gasoline power unit is available for emergency operation.

The unusual features and engineering developments which are embodied in the design and construction of the Harry S. Truman Bridge, contribute to the lasting strength and ruggedness demanded by today's and tomorrow's heavy freight tonnage, great traffic density, and high speed operations. The completed ready-for-traffic superstructure was under contract to American Bridge Company.

Projects such as this point the way to the problems now facing America's railroads—for "better railroading" is here to stay. And as your new plans of roadbed rehabilitation shape up, American Bridge Company will be prepared to meet your every structural need.

AMERICAN BRIDGE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

District Offices in: Baltimore · Boston · Chicago · Cincinnati · Cleveland Denver · Detroit · Duluth · Minneapolis · New York · Philadelphia · St. Louis

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2. A member shall be a person in a responsible position in connection with railway bridge and building work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership a member must have belonged to the association for at least ten years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

*Amended October 16, 1941.

CLEAN TREATED LUMBER for bridges and buildings, platforms, roofs and decks

Where a clean, odorless, paintable treated lumber is required, specify Wolmanized Lumber. Wolmanizing treatment introduces no inflammable material. Service records over 18 years prove its effectiveness in protecting against decay and termites.

AMERICAN LUMBER & TREATING CO.
332 SOUTH MICHIGAN AVENUE • CHICAGO

Wolmanized VACUUM-PRESSURE TREATED **LUMBER**

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9. Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers or selection of place for holding annual convention.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1. The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association but shall not have the power to render the association liable for any debt beyond the amount then in the treasury and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

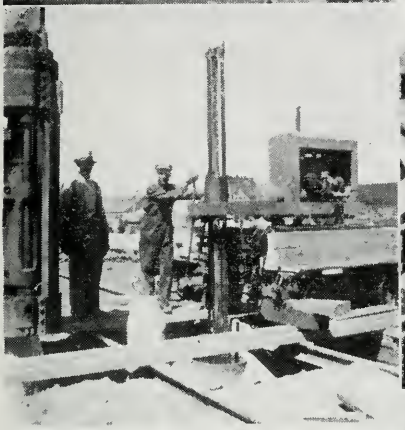
Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

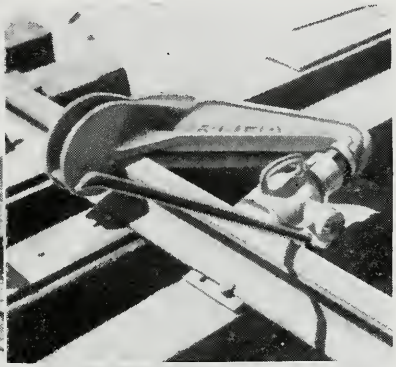
*Amended October 16, 1941.

BUDA *serving the railroads since 1881*

• **LEFT:** BUDA Power Track Drill for drilling bolt holes in "T" rail, girder rail or "I" beams, quickly and accurately. Light weight — powerful engine.

• **BELOW:** BUDA Rail Bender, bends heavy rail cold. One man bends 151 lb. rail easily with this handy tool.





• **ABOVE:** BUDA Earth Drill, highly efficient unit for all types of bridge and construction work. Model HBD shown, is pre-boring for piling on a typical bridge job.

• **RIGHT:** BUDA Klinch-Klaw Jack, ideal for pulling bolts and spikes from bridges and trestles.

WRITE FOR LITERATURE

BUDA

HARVEY *(Chicago Suburb)* **ILLINOIS**

Section 2.† The president, four vice-presidents, secretary and treasurer shall hold office for one year and the directors for two years, three directors being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing but may receive others into affiliate membership. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING

2. The place of holding the next annual convention shall be selected by ballot at the annual meeting of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

---

†Amended October 17, 1940.

*Article adopted 1922.

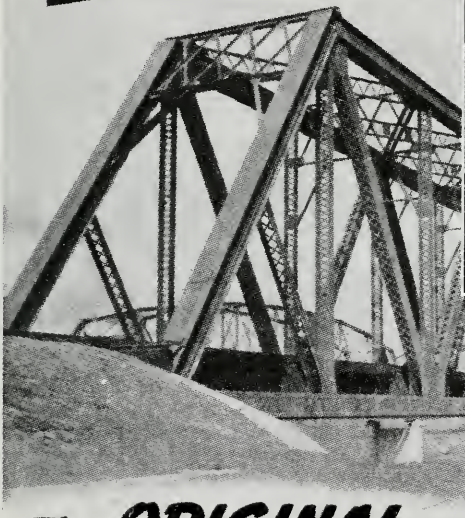
MAINTENANCE MEN

LOVE DATES

LIKE THESE....

They show years of dependable rust prevention, under conditions that accelerate corrosion. One coat application of NO-OX-ID invariably does the trick. NO-OX-ID can be brushed on over existing rust and scale. It penetrates down to the parent metal, where it stops further corrosion. Rust scale will loosen under NO-OX-ID's chemical action, bare areas may appear, exposing parent metal. All that is required is touching up of these patches. With this easy effective application, NO-OX-ID saves up to 50% of ordinary maintenance cost.

LONG-TIME DEPENDABLE PROTECTION AGAINST CORROSION . . .



NO-OX-ID IRON RUST REG. TRADEMARK AUG. 27, 1918

The ORIGINAL RUST PREVENTIVE

Dearborn Chemical Company
Dept. U, 310 S. Michigan Ave., Chicago 4, Ill.
New York • Los Angeles • Toronto

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

DUES

5. The annual dues, for the fiscal year ending September 30, and payable in advance, shall be as follows:*
Members, $4.00; Associate Members, $3.00; Junior Members, $2.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees

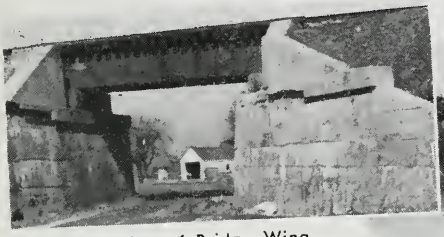
*Amended October 16, 1941.
†Amended October 17, 1940.
‡Adopted October 17, 1940.

For Bridge Trouble...

DETZEL Restoration Service...

Pressure Grouting and "Guniting" of

Disintegrated concrete and masonry structures such as piers and abutments of railroad bridges, retaining walls, power plants, dams, steel encasements, and linings for tanks, reservoirs, tunnels, canals and ditches.



Condition of Bridge Wing Walls before starting work

After Restoration Service

Note condition of disintegrated concrete Wing Wall at left

After Restoration Service

Let a Detzel Engineer Help You . . .

with Your Masonry Maintenance Problems

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The "McGarry" Hydrant is designed to meet the requirements of the United States Public Health Service.

Its design is simple; fully automatic—a compact unit, easily serviced, protecting potable water passing through the Hydrant—therefore, pollution proof.

Contamination of potable water has been eliminated in the construction of the McGarry Hydrant. The Drain Port or Weep-hole is not exposed to any outside source of contamination, and the anti-freeze feature has been retained.

The Hydrant Reservoirs are below ground line, constructed of heavy galvanized steel pipe. A brass cap together with brass base, with Four-way Inlet are attached firmly to the Steel Pipe Reservoirs.

The Purpose of the Reservoirs is to store the "drained water" which drains back from the Hydrant's Discharge Pipe after the Hydrant has been shut off. When this "drained water" reaches a pre-determined height in the Reservoir of the McGarry Hydrant, the Ejector Device then ejects the "drained water" up and out through the Surface Discharge Tube. This "drained water" is discharged from the Surface Discharge Tube through an Air Gap of not less than 4½" to a sewer or other means for the disposal of all waste water away from the Hydrant.

The 4½" Air Gap is a positive protection against drained water seeping back into the Hydrant from any outside source that would contaminate potable water passing through the Hydrant.

Write for our Catalogue No. 600. It is fully descriptive of the McGarry Hydrant.

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POAGE WATER COLUMNS

ECONOMY AND RAPRO SWITCH STANDS

Are
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who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Selection of place for next annual meeting.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise all discussions shall be governed by Robert's rules of order.

†Amended October 17, 1940.

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BRIDGE CONSTRUCTION

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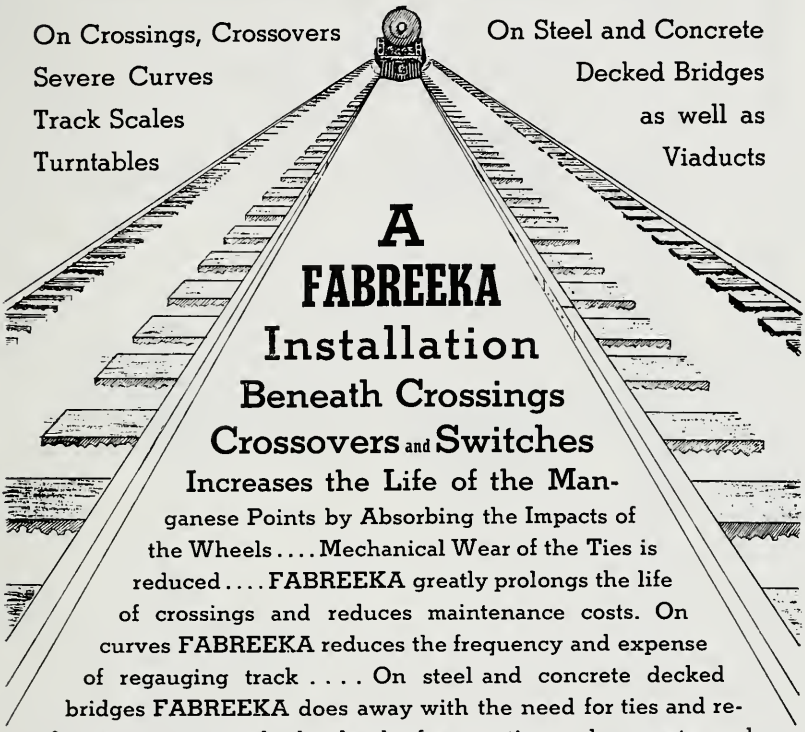
Track Scales
Turntables

On Steel and Concrete
Decked Bridges
as well as
Viaducts



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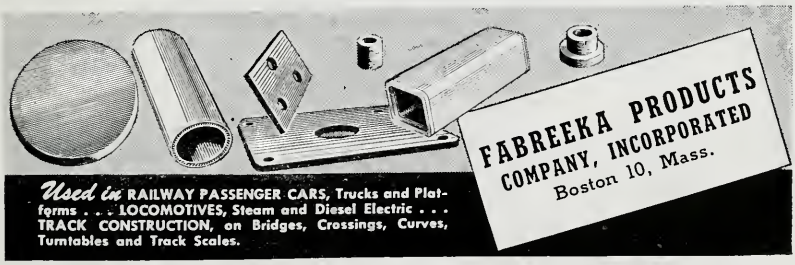
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DIRECTORY OF MEMBERS

As of April 1, 1947

(Figure after each name indicates year when member joined the association. Asterisk (*) indicates members who served in armed forces during 1941-46, inclusive and whose dues were waived for the duration by action of the Executive Committee.)

ACTIVE MEMBERS

H. C. Aaron, Supv. B. & B., W. M. R. R., Hagerstown, Md., (1935).
L. G. Aldrich, Dist. B. & B. For., N. Y. N. H. & H. R. R., South Braintree, Mass., (1934).
G. A. Allen, Br. Insp., C. & O. Ry., Clifton Forge, Va., (1940).
W. V. Allen, Asst. Supv. B. & B., C. & O. Ry., Catlettsburg, Ky., (1946).
J. L. Anderson, Sup. B. & B., Mo. Pac. R. R., Osawatomie, Kans., (1931).
R. D. Anderson, Div. Engr., C. & N. W. Ry., Huron, S. D. (retired), (1923).
W. L. Anderson, Off. Engr., C. & N. W. Ry., Chicago, (1935).
R. L. Antcliff, B. & B. Fore., P. M. Ry., Grand Ledge, Mich.
C. A. Appell, Mast. Carp., B. & O. R. R., Cumberland, Md., (1946).
L. K. Arnold, Div. Br. Insp., A. T. & S. F. R. R., San Bernardino, Calif., (1944).
R. L. Autcliff, W. S. Repmn., P. M. R. R., Grand Ledge, Mich., (1942).

J. H. Babbitt, Asst. Div. Eng., B. & O. R. R., Indianapolis, Ind., (1946).
R. C. Baker, B. & B. Supvr., C. & E. I. Ry., Danville, Ill., (1940).
M. L. Bardill, Asst. Engr., C. M. St. P. & P. R. R., Savannah, Ill., (1941).
R. C. Bardwell, Supt. W. Sup., C. & O. R. R., Richmond, Va., (1923).
E. H. Barnhart, Div. Engr., B. & O. R. R., Garrett, Ind., (1941).
G. J. Bass, Gen. For., B. B. & W. S., G. C. & S. F. Ry., Galveston, Tex., (1946).
W. A. Batey, Constr. Engr., Un. Pac. R. R., Omaha, Nebr., (1918).
Y. C. Beam, Asst. Mast. Carp., S. A. L. Ry., Americus, Ga., (1945).
A. E. Bechtelheimer, Engr. of Br., C. & N. W. Ry. System, Chicago, (1920).
W. H. Begeman, B. & B. Supvr., Mo. Pac. R. R., Nevada, Mo., (1941).
J. G. Begley, Div. Engr., B. & O. R. R., Washington, Ind., (1946).
H. I. Benjamin, Vice-Chair. Sys., Com. on Ins., So. Pac. Ry., San Francisco, Cal., (1922).
H. F. Bennett, Mast. Carp., Erie R. R., Dunmore, Pa., (1934).
G. W. Benson, Supvr. B. & B., C. of G. Ry., Macon, Ga., (1940).
M. A. Beringer, Br. Insp., I. C. R. R., Chicago, (1929).
W. L. Biggerstaff, Asst. Supv. B. & B., C. N. S. & M. R. R., Racine, Wis., (1945).
H. F. Bird, Supv. B. & B., N. Y. C. Sys., Syracuse, N. Y., (1937).
E. H. Blewer, Sup. Saf. Engr., N. Y. C. Sys., New York, (1937).
E. W. Bolmgren, Div. Engr., C. M. St. P. & P. R. R. Co., LaCrosse, Wis., (1937).
W. C. Borchert, Div. Engr., L. & A. Ry., Shreveport, La., (1942).
M. A. Bost, Asst. Engr., C. M. St. P. & P. R. R., Mason City, Iowa, (1935).
G. E. Boyd, Assoc. Ed. Ry. Engr. & Mtce., Chicago (retired), (1911).
R. H. Brandt, Mast. Carp., C. B. & Q. R. R., Galesburg, Ill., (1946).
W. T. Brice, B. & B. Master, C. N. R., Regina, Sask., Can., (1946).
* **V. S. Brokaw,** Asst. Engr., C. M. St. P. & P. Ry., Chicago, (1927).
G. A. Brown, Gen. For. B. & B., A. T. & S. F. Ry., Wellington, Kans., (1946).
R. J. Bruce, Asst. Engr., Mo.-Ill. R. R., Bonne Terre, Mo., (1946).
F. N. Budzenski, Asst. Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1938).
H. M. Buell, Bridge Insp. U. P. R. R., Omaha, Nebr., (1937).
W. H. Bunge, Asst. Engr., M. P. Lines, Houston, Tex., (1941).
E. E. Burch, Strl. Engr. Dftsman, C. M. St. P. & P. R. R., Chicago, (1945).
C. M. Burpee, V.-P. Simmons-Boardman Pub. Corp., New York, (1930).
C. D. Burrows, Mast. Carp., B. & O. R. R., Wilmington, Del., (1946).
L. G. Byrd, Supvr. B. & B., Mo. Pac. R. R., Poplar Bluff, Mo., (1926).

W. W. Caines, Asst. Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1938).
F. G. Campbell, Ch. Engr., E. J. & E. Ry., Joliet, Ill., (1936).
J. P. Canty, Asst. to Engr. M. of W., B. & M. R. R., Boston, Mass., (1901).
M. D. Carothers, Ch. Engr., Alton R. R., Chicago, (1938).
R. B. Carruthers, Br. Engr., Sou. Pac. Co., Houston, Tex., (1946).
R. E. Caudle, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1921).
T. M. Cawthorn, Asst. B. & B. Supv., S. P. Co., Martinez, Calif., (1943).
P. C. Chamberlain, Br. Inspr., Erie R. R., Port Jervis, N. Y., (1941).
B. J. Chamberlin, Scale Supv., C. & E. I., Danville, Ill., (1940).
A. B. Chapman, Engr. & Supt. B. & B., C. M. St. P. & P. R. R., Chicago, (1938).
S. L. Chapin, Saf. Supv., So. Pac. Co., San Francisco, Calif., (1946).

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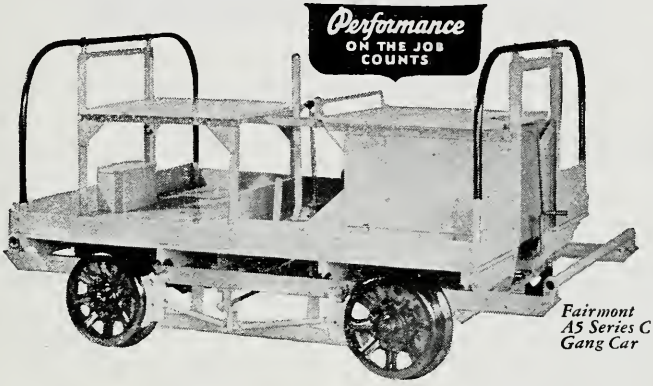

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A. Chinn, Pres., Term. R. R. Assoc. of St. L., St. Louis, Mo., (1930).
H. B. Christiansen, Asst. to Ch. Engr., C. M. St. P. & P. Ry., Chicago, (1928).
L. Christiansen, B. & B. Fore., C. M. St. P. & P. Ry., Marion, Ia.
H. M. Church, Gen. Supv., B. & B., C. & O. R. R., Richmond, Va., (1939).
M. A. Clancy, Gen. Steel Fore., D. & H. R. R., Green Island, N. Y., (1942).
L. Clapper, Ch. Engr., D. M. & I. R. Ry., Duluth, Minn., (1919).
K. L. Clark, Div. Eng., C. M. St. P. & P. R. R. Co., Aberdeen, S. D., (1939).
W. P. Clark, Supv. B. & B., L. V. R. R., Wilkes-Barre, Pa., (1944).
E. J. Clopton, Div. Engr., B. & O. R. R., Cumberland, Md. (1944).
* **J. J. Clutz**, Div. Engr., Penna. R. R., Philadelphia, Pa., (1940).
G. V. Coffey, Supv. B. & B., M. C. R. R., Jackson, Mich., (1941).
R. W. Cook, Gen. Brg. Insp., S. A. L. Ry., Norfolk, Va., (1937).
P. B. Collier, Supv. B. & B., M. P. R. R., St. Louis, Mo., (1938).
R. L. Collum, Mast. Carp., S. A. L. Ry., Jacksonville, Fla., (1941).
A. A. Colvin, Div. Engr., C. & N. W. Ry., Norfolk, Nebr., (1937).
* **R. L. Cook**, Asst. Engr., M. P. Lines, Houston, Tex., (1941).
D. W. Converse, Br. Engr., A. C. & Y. R. R., Akron, Ohio, (1940).
S. T. Corey, Off. Engr. and Engr. Br., C. R. I. & P. Ry., Chicago, (1913).
C. O. Coverley, Sys. Arch., A. T. & S. F. Ry., Chicago, (1946).
L. A. Cowsert, W. Insp., B. & O. R. R., Dayton, Ohio, (1915).
F. H. Cramer, Br. Engr., C. B. & Q. R. R., Chicago, (1927).
H. C. Crawford, Supv. B. & B., So. Pac. Co., Oakland, Calif., (1934).
F. W. Creedle, Div. Eng., C. & N. W. Ry., Green Bay, Wis., (1942).
G. S. Crites, Div. Eng., B. & O. R. R., Baltimore, Md., (1912).
S. P. Critz, B. & B. Supv., I. C. R. R., McComb, Miss., (1946).
M. Cronin, Gen. B. & B. For., So. Pac. Co., Tucson, Ariz., (1943).
W. E. Crounse, Supv. B. & B., D. & H. R. R., Plattsburg, N. Y., (1945).
H. D. Curie, Mast. Carp., B. & O. R. R., Garrett, Ind., (1942).

G. B. Davis, B. & B. Supv., N. Y. C. R. R., Columbus, Ohio, (1942).
H. E. Davis, B. & B. Supv., N. Y. C., Chicago, (1940).
C. E. Dawson, B. & B. Supv., St. L. S. W. Ry. Co. of Tex., Tyler, Tex., (1945).
E. G. Day, Ch. Engr., L. S. & I. R. R., Marquette, Mich., (1923).
R. DeArmond, Asst. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1938).
A. H. Deno, Supv., B. & B., C. & N. W. Ry., Green Bay, Wis., (1941).
E. J. De Witt, Off. Engr., N. Y. O. & W. Ry., Middletown, N. Y., (1944).
H. M. Dick, Mast. Carp., Penn. R. R., Columbus, Ohio, (1942).
M. H. Dick, Man. Ed., Ry. Engr. & Mtce., Chicago, (1937).
* **C. Djuvik**, Asst. Supv., B. & B., T. C. R. R., Nashville, Tenn., (1938).
C. E. Donaldson, Supv. B. & B., C. V. Ry., St. Albans, Vt., (1909).
A. G. Dorland, Asst. Engr., E. J. & E. Ry., Joliet, Ill., (1941).
J. L. Dougherty, Supv. B. & B., W. M. Ry., Cumberland, Md., (1944).
R. E. Dove, Man. Ed., Ry. Engr. & Mtce. Cycl., Chicago, (1934).
J. V. Duchac, Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1927).
J. P. Dunnagan, Engr. of Br., So. Pac. Co., San Francisco, Calif., (1943).
F. Duresky, Jr., Asst. Supv. B. & B., C. & N. W. Ry., Milwaukee, Wis., (1942).

C. M. Eichenlaub, Res. Engr., S. D. & A. E. Ry. Co., San Diego, Cal., (1943).
C. Eisele, Asst. Engr., N. Y. C. Sys., Chicago, (1930).
F. G. Elmquist, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1936).
V. E. Engman, Ch. Carp., C. M. St. P. & P. R. R., Savanna, Ill., (1920).
C. C. Eubank, Asst. Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1938).
D. J. Evans, Div. Eng., B. & O. C. T. Ry., Chicago, (1946).
L. I. Evans, Instmn., C. M. St. P. & P. R. R., Savanna, Ill., (1937).

E. L. Farmer, Rdm., St. L. S. W. Ry., Lewisville, Ark., (1946).
L. M. Firehammer, Gen. Supv. B. & B., Ill. Term. R. R., Springfield, Ill., (1919).
T. J. Flessa, Supv. B. & B., M. P. R. R., Sedalia, Mo., (1941).
L. B. Franco, Asst. to Eng. M. of W., S. P. & S. Ry., Portland, Ore., (1945).
W. H. Freeman, B. & B. Supv., C. G. W. Ry., Oelwein, Iowa, (1946).
C. G. Friets, Supv. B. & B., C. & N. W. Ry., Escanaba, Mich., (1938).
A. H. Frisbie, For. W. Ser., C. & N. W. Ry., Sioux City, Iowa, (1939).
L. M. Frost, Supv. B. & B., G. T. W. Ry., Battle Creek, Mich., (1938).
B. J. Furniss, B. & B. Supv., N. Y., N. H. & H. R. R., Hartford, Conn., (1946).

C. E. Garcelon, Supt. B. & B., B. & A. R. R., Houlton, Me., (1945).
L. D. Garis, Gen. Br. Inspr., C. & N. W. Ry., Chicago, (1939).
* **L. R. Garman**, Insp. B. & B., P. R. R., Cleveland, Ohio, (1935).
A. L. Garrity, Br. Insp., P. M. Ry., Detroit, Mich., (1945).
P. Gepford, Asst. Supv. B. & B., N. Y. C., Matoon, Ill., (1945).
A. Gerske, Box 343, 1185 Hillcrest Blvd., Millbrae, Cal. (retired), (1938).
C. J. Geyer, Asst. Vice-Pres., C. & O. Ry., Richmond, Va., (1928).
W. D. Gibson, Asst. Eng., C. B. & Q. R. R., Chicago, (1946).

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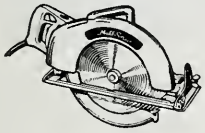

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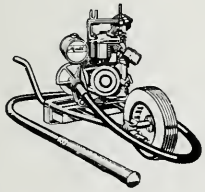

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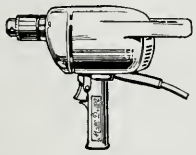

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J. M. Giles, Asst. Eng. Br., M. P. R. R., St. Louis, Mo., (1938).
W. G. Gillespie, Mast. Carp., B. & O. R. R., Grafton, W. Va., (1946).
A. D. Gillis, B. & B. Supv., N. Y., N. H. & H. R. R., Providence, R. I., (1923).
R. W. Gilmore, Gen. Br. Insp., B. & O. R. R., Cincinnati, Ohio, (1943).
F. M. Ginter, W. S. For., Alton R. R., Bloomington, Ill., (1939).
A. M. Glander, Ch. Carp., C. M. St. P. & P. Ry., Mason City, Iowa, (1936).
J. A. Goforth, Asst. Engr., Clinchfield R. R. Co., Erwin, Tenn., (1944).
B. H. Goodwin, Supv. B. & B., So. Ry., Atlanta, Ga.
H. E. Graham, Asst. Supt. W. S., I. C. R. R., Chicago, (1946).
W. R. Graham, Asst. Supt. B. & B., C. & O. R. R., Covington, Ky., (1946).
E. Gram, Asst. B. & B. Supv., So. Pac. Co., Soda Springs, Cal., (1934).
K. E. Grinnell, Rdm. and Supv. B. & B., N. & W. Ry., Norfolk, Va., (1946).
E. Gunderson, Supt. B. & B., C. St. P. M. & O. Ry., Altoona, Wis., (1927).
B. W. Guppy, Engr. Str., B. & M. R. R., Boston, Mass., (1914).

E. H. Haase, B. & B. Supv., So. Pac. Co., Tucson, Ariz., (1943).
C. A. Hackett, Asst. B. & B. Supv., So. Pac. Co., El Paso, Tex., (1943).
L. D. Hadwen, C. M. St. P. & P. R. R., Chicago (retired), (1907).
P. Haines, Asst. B. & B. Supv., P. M. Ry., Saginaw, Mich., (1943).
J. S. Hancock, Br. Engr., D. T. & I. R. R., Dearborn, Mich., (1916).
G. W. Hand, Asst. to Pres., C. & N. W. Ry., Chicago, (1909).
J. P. Hanley, Asst. Supt. W. S., I. C. R. R., Chicago, (1941).
A. H. Hansbury, Gen. For. B. & B.-W. S., A. T. & S. F. Ry., Las Vegas, N. M., (1946).
C. R. Harding, Asst. to Pres., So. Pac. Co., San Francisco, Cal., (1924).
H. M. Harlow, Asst. Gen. Supv. B. & B., C. & O. Ry., Richmond, Va., (1939).
W. C. Harman, Supv. B. & B., So. Pac. Co., San Francisco, Calif., (1911).
M. J. Harp, Supv. B. & B., M. P. R. R., Wichita, Kans., (1938).
A. R. Harris, Asst. Engr. of Br., C. & N. W. Ry., Chicago, (1940).
E. M. Hastings, Ch. Eng., R. F. & P. R. R., Richmond, Va., (1940).
J. Hayes, Arch., Gr. No. Ry., St. Paul, Minn., (1942).
J. E. Heck, Asst. Supv. B. & B., C. & O. Ry., Ashland, Ky.
R. D. Hellweg, Asst. Div. Eng., Alton R. R., Bloomington, Ill., (1947).
B. Hemstad, Mast. Carp., Gr. Nor. R. R., Willmar, Minn., (1937).
H. R. Herrick, Asst. B. & B. Supv., So. Pac. Co., Bakersfield, Cal., (1941).
H. Heizenbuttel, Supv. B. & B., C. & N. W. Ry., Norfolk, Nebr., (1917).
* **M. A. Higgins**, Dftsmn, C. & N. W. Ry., Chicago, (1940).
C. G. Hill, Asst. Mast. Carp., P. R. R., Steubenville, Ohio, (1946).
R. F. Hill, Supv. B. & B., C. I. & L. Ry., Crawfordsville, Ind. (retired), (1935).
A. B. Hillman, Engr. M. of W., C. & W. I.-Belt Ry., Chicago, (1942).
F. W. Hillman, Asst. Engr. M. of W., C. & N. W. Ry., Chicago, (1917).
W. C. Hillman, Mast. Carp., Clinchfield Ry., Erwin, Tenn., (1945).
* **R. C. Hilton**, Asst. Eng., M. P. Lines, Houston, Tex., (1941).
P. W. Hofstetter, Br. Insp., M. P. R. R., San Antonio, Tex., (1946).
V. V. Holmberg, Supv. B. & B., C. & W. I. Ry., Chicago, (1942).
G. H. Holmes, Supv. B. & B., M. P. Lines, Nevada, Mo., (1929).
K. B. Hornung, Arch. Drftsmn., C. M. St. P. & P. R. R., Chicago, (1942).
N. D. Howard, West. Ed., Railway Age, Chicago, (1926).
B. J. Howay, Supv. B. & B.-W. S., P. M. Ry., Grand Ledge, Mich., (1919).
M. W. Hubbard, B. & B. Frmn., K. C. S. Ry., Texarkana, Tex., (1945).
W. A. Huckstep, Gen. Bldg. Supv., M. P. R. R., St. Louis, Mo., (1941).
W. H. Huffman, Div. Engr., C. St. P. M. & O. Ry., St. Paul, Minn., (1941).
C. A. Hughes, Supt. B. & B., E. J. & E. Ry., Joliet, Ill., (1943).
H. A. Hunt, B. & B. Supv., T. & N. O. R. R. Co., Houston, Tex., (1946).
J. S. Huntoon, Asst. Engr., M. C. R. R., Detroit, Mich., (1915).
F. C. Huntsman, Asst. Eng., Wab. R. R., St. Louis, Mo., (1922).
F. W. Hutcheson, Asst. Supv. B. & B., C. & O. Ry., Newport News, Va., (1938).
W. A. Hutcheson, Supv. B. & B., C. & O. Ry., Clifton Forge, Va., (1939).
V. W. Hutchings, B. & B. Supv., S. P. Co., Bakersfield, Calif., (1941).
J. S. Hyatt, Ch. Engr., C. N. S. & M. Ry., Chicago, (1944).

H. E. Jackman, Mast. Carp., B. & O. R. R., Chillicothe, Ohio, (1944).
C. E. Jacobson, Engr. B. & B., A. & W. P., W. of A., Ga. R. R., Atlanta, Ga., (1946).
H. W. Jenkins, Supv. B. & B., N. Y. N. H. & H. R. R., Boston, Mass., (1940).
W. J. Jerrow, Asst. Mast. Carp., G. N. Ry., Whitefish, Mont., (1946).
E. S. Joehnk, Asst. Eng. Con. & Maint., B. & O. C. T. R. R., Chicago, (1946).
A. C. Johnson, Asst. Supt. B. & B., E. J. & E. Ry., Joliet, Ill., (1944).
B. O. Johnson, Asst. Engr., C. M. St. P. & P. Ry., Chicago.
D. H. Johnson, Supt. B. & B., C. St. P. M. & O. Ry., Spooner, Wis., (1940).
E. H. Johnson, Div. Engr., C. M. St. P. & P. R. R., Spokane, Wash., (1940).
H. G. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Ottumwa, Ia.
M. Johnson, Prin. Asst. Engr., I. C. R. R., Chicago, (1915).
R. W. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1922).

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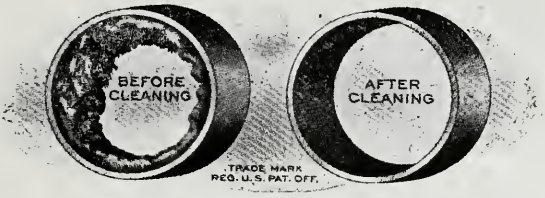
J. A. Jorlett, Mast. Carp., Penna. R. R., Pittsburgh, Pa., (1946).
L. Jutton, 828 N. Broadway, Milwaukee, Wis. (retired), (1905).

C. T. Kaier, Gen. Br. Insp., D. L. & W. R. R., Hoboken, N. J., (1937).
R. D. Kelly, Asst. Supt. B. & B., C. & N. W. Ry., Chicago.
W. G. Kemmerer, Asst. Engr. B. & B., Penna. R. R., New York.
W. V. Kerns, Supt. B. & B., C. & N. W. Ry., Mason City, Iowa, (1924).
L. P. Kimball, Eng. Bldg., B. & O. R. R., Baltimore, Md., (1921).
T. R. Klingel, Div. Engr., M. St. P. & S. S. M. Ry., Minneapolis, Minn., (1943).
C. R. Knowles, Supt. W. S., I. C. R. R., Chicago (retired), (1912).
P. L. Koehler, Asst. Supt., C. & O. Ry., Peach Creek, W. Va., (1938).
A. S. Krefting, Prin. Asst. Eng., M. St. P. & S. S. M. Ry., Minneapolis, Minn. (1935).
S. E. Kvenberg, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1932).

W. S. Lacher, Secy., Am. Ry. Engr. Assoc., Chicago, (1922).
W. J. Lacy, Supv., B. & B., M. P. R. R., Jefferson City, Mo., (1911).
L. R. Lamport, Engr. of Maint., C. & N. W. Ry. Sys., Chicago, (1935).
W. Lampson, Supv., B. & B., Maine Cent. R. R., Portland, Me., (1930).
C. R. Letzkus, 636 W. 10th St., Fremont, Nebr., (1930).
F. W. Lichtenberger, Jr., Asst. Mast. Carp., Erie R. R., Paterson, N. J., (1945).
J. H. Lindsay, Div. Eng., B. & O. R. R., Grafton, W. Va., (1946).
H. M. Link, Asst. Supv. B. & B., C. & N. W. Ry., Winona, Minn., (1940).
G. A. Linn, Supt. B. & B., C. & N. W. Ry., Boone, Iowa, (1940).
C. A. Little, Asst. Supv. B. & B., B. & M. R. R., Concord, N. H., (1918).
P. E. Littles, Mast. Carp., C. B. & Q. R. R., St. Joseph, Mo., (1945).
Tseng-ta Liu, Chungking, China, (1945).
H. T. Livingston, Eng. of Br., C. R. I. & P. Ry., Chicago, (1941).
E. M. Loebs, Asst. Eng., B. & B., C. & I. M. R. R., Springfield, Ill. (1946).
H. T. Lord, B. & B. Master, Can. Pac. Ry., Kenora, Ont.
R. P. Luck, Dftsman, C. & N. W. Ry., Chicago, (1920).
C. V. Lund, Asst. Eng., C. M. St. P. & P. R. R., Chicago, (1947).
W. H. Lytle, Supv. B. & B., N. Y. C. Lines, Anderson, Ind., (1945).

H. C. Madson, Dftsman, C. & N. W. Ry., Chicago, (1940).
W. J. Mahoney, Supv. B. & B., L. & N. R. R., Louisville, Ky., (1946).
C. D. Malloy, B. & B. For., M. P. Ry., Piedmont, Mo., (1940).
B. F. Manley, Supv. B. & B., Pac. Elec. Ry. Co., Los Angeles, Cal., (1943).
D. A. Manning, Supt. B. & B., C. & N. W. R. R., Chicago, (1939).
W. J. H. Manning, Div. Eng., D. & H. R. R., Plattsburg, N. Y., (1923).
W. F. Martens, Gen. Frmn., B. & B., A. T. & S. F. R. R., San Bernardino, Calif., (1924).
G. E. Martin, Supt. W. S., I. C. R. R., Chicago, (1942).
I. U. Martin, Mast. Carp., S. A. L. R. R., Raleigh, N. C., (1946).
T. J. Martin, Gen. Mast. Carp., G. N. Ry., Seattle, Wash., (1940).
W. J. Martindale, B. & B. Mast., T. H. & B. Ry., Hamilton, Ont., (1934).
E. L. Mason, B. & B. Supv., Mo. Pac. Ry. Co., Kingsville, Tex., (1946).
H. M. Mason, Gen. Frmn. B. & B., A. T. & S. F. Ry., Pueblo, Colo., (1936).
F. H. Masters, Spec. Eng., E. J. & E. R. R., Joliet, Ill., (1920).
W. G. Mateer, Pur. Agent, E. J. & E. Ry., Chicago, (1944).
L. Mayfield, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1944).
J. McCaffery, Asst. Gen. Br. Insp., Sou. Pac. Co., San Francisco, Cal., (1922).
J. F. McCay, Asst. Supv. B. & B., N. Y. C. Lines, Chicago, (1945).
C. A. McColgin, Mast. Carp., C. B. & Q. R. R., Hannibal, Mo., (1946).
M. McCollum, Sup. W. S., I. C. R. R., Paducah, Ky., (1944).
A. A. McDermott, B. & B. Supv., So. Pac. Co., Dunsmuir, Calif., (1945).
O. R. McIlhenny, Asst. Supt., T. C. & I. R. R., Ensley, Ala., (1916).
H. C. McNaughton, Supv. B. & B., B. & M. R. R., Greenfield, Mass., (1915).
H. C. Meddles, Div. W. S. For., A. T. & S. F. Ry., Winslow, Ariz., (1944).
W. R. Meeks, B. & B. Supv., M. P. R. R., Falls City, Nebr., (1942).
B. W. Merrill, Supv. B. & B., N. Y. C. & St. L. R. R., Conneaut, Ohio, (1936).
P. B. Merwin, Asst. Eng., C. & N. W. Ry., Chicago, (1927).
B. R. Meyers, Asst. to Ch. Engr., C. & N. W. Ry., Chicago, (1946).
C. E. Miller, Asst. Engr. Mtce., C. & N. W. Ry. Co., Chicago, (1916).
C. L. Miller, B. & B. Dept., S. P. Co., Sacramento, Calif.
J. O. Miller, Mast. Carp., B. & O. R. R., Washington, Ind., (1945).
* **K. L. Miner,** Engr. Br., N. Y. C. R. R., Albany, N. Y., (1937).
F. M. Misch, Gen. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1937).
A. J. Moore, Asst. B. & B. Supv., M. P. Lines, Eunice, La., (1940).
E. W. Moore, Mast. Carp., C. B. & Q. R. R., Centerville, Iowa, (1942).
I. A. Moore, Sr. Asst. Engr., C. & E. I. R. R., Danville, Ill., (1937).
L. R. Morgan, Fire Prev. Eng., N. Y. C. R. R., Detroit, Mich., (1937).
E. N. Morin, B. & B. Mast., C. P. R., Farnham, Que., (1946).



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C. H. Mottier, V.-P. & Ch. Eng.. I. C. Sys., Chicago, (1942).

E. R. Nelson, Supv. B. & B.. C. & N. W. Ry., Huron, S. D., (1937).
*** C. P. Nicholson.** Asst. Ch. Eng., Nor. Sou. R. R., Norfolk, Va., (1942).
M. S. Norris. Asst. Eng., B. & O. R. R., Pittsburgh, Pa., (1946).
C. O. Nuckolls, Ch. Eng.. S. S. Ry. Co., Sand Springs, Okla.
W. Nuetzel, Asst. Engr. Const. & Maint., B. & O. C. T. Ry., Chicago, (1945).

A. Olson, Supv., B. & B., C. & N. W. Ry.. Chicago, (1920).
G. Olson. Asst. Supt. B. & B.. C. & N. W. Ry., Huron, S. D., (1944).
T. D. Osbourne, Asst. B. & B. Supv.., So. Pac. Co., Alhambra, Calif., (1943).

A. M. Partch, Asst. Supv. B. & B., N. P. Ry., Spokane, Wash., (1940).
E. Patenaude, B. & B. Mast., C. P. R., Sudbury, Ont., Can., (1930).
R. E. Paulson, Ch. Dftsman, C. M. St. P. & P. R. R., Chicago, (1945).
J. R. Penhallegon, Asst. B. & B. Supt., C. & N. W. Ry., Chicago.
L. R. Pennington, B. & B. Supv., C. & N. W. R. R., Chadron, Nebr., (1938).
W. C. Peters, Mast. Carp., B. & O. C. T. R. R. Co., Chicago, (1946).
L. E. Peyser, Prin. Asst. Arch., Sou. Pac. Co., San Francisco, Cal., (1937).
A. Pfeiffer, Asst. B. & B. Supv., So. Pac. Co., Stockton, Calif., (1939).
W. J. Phillips, Asst. Gen. Br. Insp., So. Pac. Co., Berkeley, Calif., (1925).
C. Piccone, Engr. of Br., Nat. Rys. of Mexico, Mexico City, D. F., Mex., (1923).
T. W. Pinard, B. & B. Engr., Penn. R. R., New York, (1920).
N. F. Podas, Ch. Engr., Minn. Trans. Co. & St. Paul Un. Depot Co., St. Paul, Minn., (1937).
L. F. Pohl, Div. Engr., C. M. St. P. & P. R. R., Ottumwa, Iowa, (1937).
H. L. Porter, Asst. B. & B. Supv.. So. Pac. Co., Ogden, Utah, (1945).
H. M. Potts. Mast. Carp.. B. & O. R. R.. Wheeling, W. Va., (1946).
W. G. Powrie, Engr. M. of W.. C. M. St. P. & P. R. R.. Chicago, (1939).
W. H. Pryor, Gen. For. B. & B.-W. S., St. L.-S. F. Ry., Memphis, Tenn., (1946).

*** E. L. Rankin,** Arch., G. C. & S. F. Ry., Galveston, Tex., (1934).
L. F. Rapier, Supv. B. & B.. Alton R. R., Chicago, (1946).
G. W. Rear, Jr., Asst. Gen. Fire Insp.. Sou. Pac. Co., San Francisco, Calif., (1939).
A. N. Reece. Asst. to Pres.. K. C. S. Ry., Kansas City, Mo., (1922).
A. D. Reed, Mast. Carp., C. B. & Q. R. R., McCook, Nebr., (1945).
L. J. Reed, Asst. Gen. Br. Insp.. So. Pac. Co.. San Francisco, Cal., (1945).
C. A. J. Richards. Mast. Carp.. Penna. R. R.. Grand Rapids, Mich., (1924).
A. O. Ridgway. Eng. Consit., D. & R. G. W. R. R.. Denver, Colo., (1910).
H. T. Rights, Asst. Br. Engr., L. V. R. R., Bethlehem, Pa., (retired), (1927).
A. A. Riley, Supv. Str., T. & N. O. R. R.. Houston, Tex., (1936).
D. T. Rintoul, Gen. Br. Insp.. So. Pac. Co.. San Francisco, Calif., (1910).
*** F. B. Robins,** Asst. to Gen. Mgr., A. C. L. Ry., Wilmington, N. C. (1941).
N. R. Robinson, B. & B. Supv.. So. Pac. Co.. Sacramento, Calif., (1934).
W. R. Roof, Br. Engr., C. G. W. R. R., Chicago, (1927).
A. G. Rose. Sys. Scale Inspr., Mo. Pac. R. R., St. Louis, Mo.. (1942).
H. W. Routenberg. Mast. Carp., B. & O. R. R., Baltimore, Md., (1946).
J. W. Rowland. Mast. Carp.. Penna. R. R., Jamaica, N. Y., (1937).
C. E. Russell, Supv. W. S.. Ill. Cent. R. R., Chicago. (1944).
V. J. Ryan, Asst. Eng., D. T. & I. R. R. Co., Dearborn, Mich., (1945).

J. R. Safely, Asst. B. & B. Supv., So. Pac. Co.. Dunsmuir, Calif., (1945).
J. M. Salmon, Jr., Asst. Br. Insp.. L. & N. R. R., Louisville, Ky., (1938).
C. O. Sathre, Asst. Supv. B. & B., C. & N. W. Ry., W. Chicago, (1941).
T. D. Saunders, Ch. Engr., Northland Ry.. North Bay, Ont., Can., (1930).
L. H. Schaeperklaus, Asst. Eng., N. Y. C. R. R., Cincinnati, Ohio, (1943).
P. J. Scherer, Supv. B. & B., So. Pac. Co., El Paso, Tex., (1936).
F. F. Schilt, Asst. Div. Engr., B. & O. R. R., Grafton, W. Va., (1946).
F. A. Scites, Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1939).
E. S. Scott, Asst. Div. Eng, Erie R. R. Co., Buffalo, N. Y., (1945).
C. Sedmiradsky, Supv. B. & B.. C. St. P. M. & O. Ry., Spooner, Wis., (1914).
C. J. Shapland, Asst. Engr. B. & B., C. V. Ry. Co., St. Albans, Vt., (1945).
T. J. Sheehy, Gen. Plumber For., D. & H. R. R., Plattsburg, N. Y., (1928).
S. H. Shepley, Asst. Ch. Engr., E. J. & E. Ry., Joliet, Ill., (1945).
F. Shobert, Sys. Steel Const. Frm.. So. Pac. Co., Oakland, Cal., (1918).
J. R. Showalter, Br. Engr., M. P. R. R., St. Louis, Mo., (1942).
E. W. Singer, Supv. B. & B., N. Y. C. & St. L. R. R., Fort Wayne, Ind., (1923).
A. A. Sirel, Br. Asst., A. A. R., Chicago, (1940).
G. L. Sitton, Asst. Ch. Engr., So. Ry. Sys., Washington, D. C., (1920).
H. E. Skinner, Supv. S. & W. Equip., E. J. & E. Ry., Joliet, Ill., (1944).
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C. E. Smith, Vice-Pres., N. Y. N. H. & H. R. R., New Haven, Conn., (1911).
C. U. Smith, Cons. Engr., Lindsay, Calif., (1915).
F. W. Smith, Assoc. Ed., Railway Age, Chicago, (1944).
H. E. Smith, Engr. M. of W., G. H. & H., Galveston, Tex., (1941).
J. Smith, Asst. B. & B. Supv., So. Pac. Co., Sacramento, Cal., (1943).
L. C. Smith, Div. Engr., C. & N. W. Ry., Escanaba, Wis., (1942).
J. W. Snyder, Supv. B. & B., N. Y. O. & W. Ry., Middletown, N. Y., (1945).
R. H. Snyder, Asst. Arch., So. Ry. Co., Cincinnati, Ohio, (1946).
* **W. J. Solomekin,** Const. Acct., C. & N. W. Ry., Chicago, (1940).
D. Speaker, Mast. Carp., Penna. R. R., Steubenville, Ohio, (1928).
W. A. Spell, Engr. M. of W., A. C. L. Ry., Atlanta, Ga., (1941).
F. R. Spofford, Asst. Div. Engr., B. & M. R. R., Dover, N. H. (1940).
G. L. Staley, Br. Engr., M.-K.-T. R. R., St. Louis, Mo., (1946).
G. T. Steidel, Br. Eng., L. & N. E. R. R., Bethlehem, Pa., (1946).
B. M. Stephens, Arch. Engr., T. & N. O. R. R., Houston, Tex., (1946).
O. W. Stephens, Asst. Eng. Str., D. & H. R. R., Albany, N. Y., (1941).
I. F. Stern, Con. Engr., Chicago, (1943).
F. J. Stewart, Port. Engr., Port Everglades Belt Lines Ry., Port Everglades (Ft. Lauderdale), Fla., (1944).
T. H. Strate, Div. Engr., C. M. St. P. & P. Ry., Chicago, (1918).
J. A. Strouss, Asst. B. & B. Supv., Sou. Pac. Co., Sacramento, Calif., (1934).
W. J. Strout, Ch. Engr., B. & A. R. R., Houlton, Me., (1932).
G. F. Stull, B. & B. For., K. C. S. Ry., Beaumont, Tex., (1945).
L. Sullivan, Supv. B. & B., Ill. Cent. R. R., Carbondale, Ill., (1944).
G. L. Summers, W. S. Rep., Mo. Pac. R. R., Bismarck, Mo., (1940).
W. A. Sweet, Gen. Frm. B. & B., A. T. & S. F. Ry., Newton, Kans., (1928).

C. R. Taggart, Supv. B. & B., N. Y. C. R. R., Indianapolis, Ind., (1935).
E. E. Tanner, Gen. Supv., B. & B., N. Y. C. Sys., Albany, N. Y., (1938).
E. R. Tattershall, Supt. of Mtce. Eqpt., N. Y. C. Sys., Mt. Vernon, N. Y., (1913).
L. J. Tetreault, B. & B. For., N. Y. N. H. & H. R. R., Worcester, Mass., (1936).
P. V. Thelander, Div. Engr., C. & N. W. Ry., Chicago, (1939).
F. W. Thompson, Ch. Engr., C. R. I. & P. Ry., Chicago, (1946).
S. R. Thurman, Supv. B. & B., Mo. Pac. R. R., Nevada, Mo., (1943).
A. C. Tinsley, Supv. B. & B., N. & W. Ry., Crewe, Va., (1945).
A. G. Todd, Asst. Div. Engr., B. & O. R. R., Garrett, Ind., (1946).
D. C. Todd, Mast. Carp., Penna. R. R., Pittsburgh, Pa., (1942).
D. E. Tracy, Asst. B. & B. Supv., So. Pac. Co., Bakersfield, Calif., (1946).
E. E. R. Tratman, 217 Gary Ave., Wheaton, Ill., (retired), (1914).
J. D. Trulove, Gen. B. & B. For., S. P. Co., Sparks, Nev., (1945).
N. R. Tucker, Asst. Div. Engr., T. & N. O. R. R., Lafayette, La.
H. C. Tunison, Asst. Engr. M. of W., L. & N. E. R. R., Bethlehem, Pa., (1946).
A. E. Tupper, B. & B. For., So. Pac. Co., Stockton, Calif., (1942).
W. L. Turner, Jr., Assoc. Ed. Railway Age, Chicago, (1946).

S. G. Urban, Arch., T. & P. Ry. Co., Dallas, Tex., (1947).

W. H. Vance, Asst. Engr. M. of W., Mo. Pac. Lines, St. Louis, Mo., (1910).
E. C. Vandenburgh, Ch. Engr., C. & N. W. Ry. Sys., Chicago, (1925).
J. L. Varker, Supv. B. & B., D. & H. R. R., Carbondale, Pa., (1936).
H. L. Veith, B. & B. Supv., So. R. R., Birmingham, Ala., (1942).
R. E. Ventress, Mast. Carp., Alton, R. R., Bloomington, Ill., (1946).
T. M. Von Sprecken, Engr. Br., So. Ry., Cincinnati, Ohio, (1938).
J. S. Vreeland, Sales Repr., Ry. Engr. & Mtce., New York, (1940).

* **S. P. Wagner,** P. M. Ry., Detroit, Mich., (1942).
R. E. Wait, Supv. B. & B., Wabash R. R., Decatur, Ill., (1923).
G. Walker, Asst. B. & B. Supv., Mo. Pac. Lines, San Antonio, Tex., (1946).
G. P. Walker, Supv. B. & B., Mo. Pac. Ry., Monroe, La., (1929).
E. G. Wall, Div. Eng., Alton R. R., Bloomington, Ill., (1942).
J. Walsh, Mast. Carp., C. B. & Q. R. R., Beardstown, Ill., (1942).
J. F. Warrenfells, Mast. Carp., S. A. L. R. R., Savannah, Ga., (1946).
L. W. Watson, Dist. Br. Insp., B. & O. R. R. Co., (Mt. Lebanon), Pittsburgh, Pa., (1944).
E. H. Weaver, B. & B. Insp., N.Y.C.R.R., Syracuse, N. Y., (1945).
T. J. Webster, Mast. Carp., C. R. I. & P. Ry., Kansas City, Mo., (1941).
K. J. Weir, Ch. Engr., W-M Corp., Chicago, (1940).
J. W. Welch, Supv. B. & B., F. E. C. Lines, St. Augustine, Fla. (1943).
W. M. Wells, Asst. Div. Eng., B. & O. R. R., Washington, Ind., (1946).
J. R. Wenzel, Gen. For. W. S., C. & N. W. Ry., Boone, Iowa, (1946).

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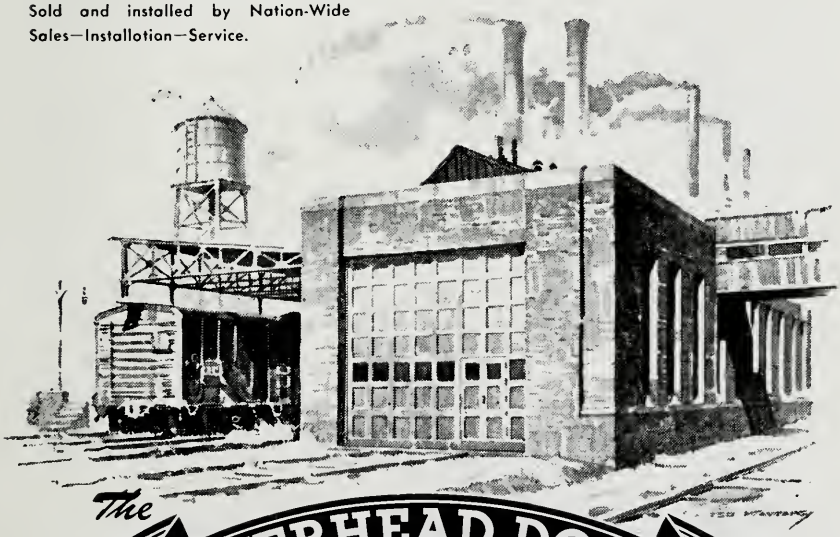

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L. H. White, B. & B. Supv., Ill. Cent. R. R., Carbondale, Ill., (1946).
S. White, Sr., Asst. B. & B. Supv., S. P. Co., El Paso, Tex., (1942).
B. M. Whitehouse, Ch. Fire Insp., C. & N. W. Ry., Chicago, (1927).
A. Wiitala, Gen. For., B. & B., L. S. & I. R. R., Marquette, Mich., (1941).
*** W. William**, Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago, (1936).
L. C. Winkelhaus, Arch. Eng., C. & N. W. Ry., Chicago, (1934).
J. J. Winn, Supv. B. & B.. B. & M. R. R., Boston, Mass., (1946).
H. A. Wistrich, Asst. Ch. Engr., L. V. R. R., New York, (1938).
H. O. Wray, Engr. M. W. & S., Tex. City Trml. Ry., Texas City, Tex., (1939).

J. E. Yewell, Engr. B. & B., B. & L. E. R. R., Greenville, Pa., (1941).
O. S. Youngblood, Asst. Supv., B. & B., C. of Ga. Ry. Co., Savannah, Ga., (1946).

LIFE MEMBERS

P. Aagaard, 6826 S. Dante, Chicago, (1906).
N. C. Ailes, Berlin Center, Ohio, (1915).
W. J. Azer, Sup. B. & B., C. & N. W. R. R., West Chicago (retired), (1920).
F. Brie, 2418 Casper Ave., Detroit, Mich., (1932).
W. Buckingham, 907 Chittock Ave., Jackson, Mich., (1928).
J. B. Clancy, 924 Melrose Ave. S., St. Petersburg, Fla., (1930).
W. A. Clark, 2718 E. 5th St., Duluth 5, Minn., (1908).
J. Conley, c/o G. W. Rear, S. P. Co., San Francisco, Cal.
G. M. Cota, St. Albans, Vt., Box 114, (1913).
H. H. Decker, 2915 Ingersoll Ave., Des Moines, Ia., (1908).
E. Drury, G. F. B. & B., A. T. & S. F. Rwy., Newton, Kan., (retired), (1919).
W. R. Edwards, Asst. Engr. Br., B. & O. R. R., Baltimore, Md. (retired), (1912).
H. H. Eggleston, 1816 E. 55th St., Kansas City, Mo., (1901).
H. A. Elwell, 1736 Marshall Ave., St. Paul, Minn., (1911).
C. Ettinger, 7046 Cornell Ave., Chicago, (1911).
M. J. Flynn, 2445 Coyle Ave., Chicago, (1905).
B. F. Gehr, 400 S. 14th St., Richmond, Ind., (1908).
I. Gentis, 2003 West St., Oakland, Calif., (1912).
H. A. Gerst, 748 Aldine St., St. Paul, Minn., (1917).
J. E. Gillette, C. M. St. P. & P., Mazomanie, Wis., (1923).
O. G. Gongoll, 2630½ DuPont Ave., Minneapolis, Minn., (1917).
B. A. Guill, Camok, Ga., (1901).
J. R. Hartwell, C. & N. W. Rwy., Pierre, S. D., (retired), (1918).
F. B. Helwig, C. R. I. & P. Ry., Little Rock, Ark. (retired), (1926).
J. P. Hofacker, 54 N. Fulton St., Auburn, N. Y., (1907).
H. A. Horning, 1106 Francis St., Jackson, Mich., (1902).
C. W. Huess, 1840 Lexington Ave., Indianapolis, Ind., (1919).
B. L. Johnson, 1007 W. 18th Ave., Spokane, Wash., (1919).
S. J. Johnson, 408 N. Center St., Marshalltown, Ia., (1922).
E. J. Knetzger, 3140 E. 27th St., Oakland, Cal., (1926).
H. Koch, N. Y. C. & St. L. Ry., Conneaut, Ohio (retired), (1922).
C. A. Landstrom, 1311 S. 3rd St., Burlington, Ia., (1928).
H. M. Large, 511 Giddings Ave., Grand Rapids, Mich., (1908).
P. P. Lawrence, N. Y. C. & St. L. Ry., Tipton, Ind. (retired).
A. Leslie, Div. For., M. C. R. R., St. Thomas, Ont., Can. (retired), (1915).
E. A. Le Wald, G. C. & S. F. Ry., Galveston, Tex. (retired), (1925).
S. Lincoln, 1903 Harrison Ave., Beaumont, Tex., (1927).
C. G. Lindstrom, Rockwell City, Iowa, (1924).
C. R. Lyman, Waterbury, Vt., (1913).
E. M. McCabe, Narragansett Ave., Rte. 1., Pentoosuc Lake, Pittsfield, Mass., (1915).
A. L. McCloy, Supv. B. & B., P. M. Ry., Saginaw, Mich. (retired), (1913).
G. G. McCue, 369 Main St., Ottawa Ont., Can., (1913).
H. A. McElhinney, 9 Beech St., Halifax, Nova Scotia, (1923).
A. G. McKay, 11 Pine Island Rd., Jupiter Pt., Groton, Conn., (1915).
T. D. McMahon, 223 Lake Ave., White Bear Lake, Minn., (1918).
E. L. Mead, 536 N. E. 69th St., Miami, Fla., (1923).
J. Mellgren, 523 N. Cadwell, Eagle Grove, Ia., (1913).
M. D. Miller, 740 Transpn. Bldg., Chicago, (1916).
A. Montzheimer, 245 LaGrande Boul., Elgin, Ill., (1897).
E. O. Newton, 64 Maple Ave., Danbury, Conn., (1915).
A. B. Nies, 408 Third St., Jackson, Mich., (1915).
W. J. O'Brien, 3413 W. Wells St., Milwaukee, Wis., (1919).
J. A. Owen, E. Tawas, Mich., (1915).
W. V. Parker, Rte. 6, Berclair, Memphis, Tenn., (1911).
P. Paulson, 547 Simmons Ave., S. E., Huron S. D., (1923).
W. R. Ratliff, McComb, Miss., (1913).
D. L. Rehmert, 104 W. 3rd Ave., Columbus, Ohio, (1918).

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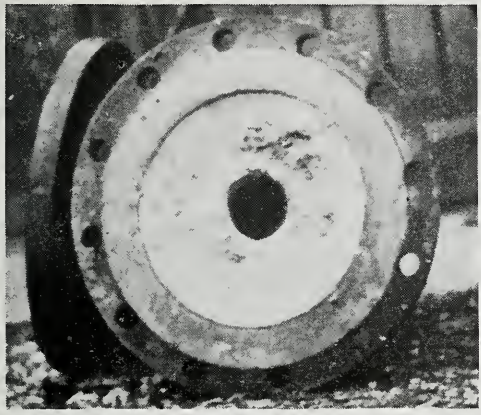

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J. Robinson, 845 Gladstone S. E., Grand Rapids, Mich., (1910).
O. F. Rowland, c/o Berkshire Industrial Farm, Canaan, N. Y., (1923).
F. B. Scheetz, 3930 Connecticut Ave., N. W., Washington, D. C., (1905).
I. L. Simmons, Winter Park, Fla., (1913).
W. Austin Stewart, Stafford Springs, Conn., (1913).
H. B. Stuart, 4205 Dorchester St., Westmount, Quebec, Can., (1913).
W. G. Swartz, C. N. R., Montreal, Que., Can. (retired), (1917).
J. L. Talbott, 228 Park St., Morgantown, W. Va., (1905).
F. A. Taylor, 2970 Mattern Ave., Dormant, Pittsburgh, Pa., (1909).
M. E. Thomas, 1015 First St., Boone, Iowa, (1915).
E. J. Vincent, 1740 S. Hoover, Los Angeles, Cal., (1911).
Dr. Hermann Von Schrenk, Tower Grove & Flad Aves., St. Louis, Mo., (retired), (1916).
W. H. Walden, 1012 Porter St., Richmond, Va., (1920).
L. A. Warren, c/o B. & B. Dept., So. Pac. Co., Sacramento, Calif. (retired), (1929).
W. Watson, c/o Ch. Engr. Off., Elgin, Joliet & Eastern Ry. Co., Joliet, Ill. (retired), (1930).
F. W. White, 409 S. Wilbur Ave., Sayre, Pa., (1915).
W. E. White, c/o A. T. & S. F. Ry., Chanute, Kans. (retired), (1920).
L. C. Wilhelm, 169 E. St. Joseph St., Easton, Pa., (1921).
J. J. Wishart, 21 Elmlawn Rd., Braintree, Mass., (1915).
C. F. Womeldorf, 111 N. 12th St., Norfolk, Nebr., (1917).
J. P. Wood, 518 N. Lake Ave., Lakeland, Fla., (1911).
C. W. Wright, 67 Nassau Pkwy., Oceanside, N. Y., (1908).
H. Wuerth, c/o Div. Engr., C. M. St. P. & P. R. R., Savanna, Ill. (retired), (1919).
R. C. Young, 719 Pine St., Marquette, Mich., (1907).
E. C. Zinsmeister, 142 Wabash Dr., Lexington, Ky., (1905).

CHARTER MEMBER

G. W. Gooch, 13125 W. 9th St., Des Moines, Iowa (retired), (1891).

HONORARY MEMBERS

Ralph Budd, Pres., Burlington Lines, Chicago, (1927).
Charles H. Buford, Exec. VP., C. M. St. P. & P. Ry., Chicago, (1946).
C. E. Johnston, Chairman, West. Assoc. Ry. Ex., Chicago, (1911).
Fred L. Thompson, Illinois Central, 6906 Constance Ave., Chicago (retired), (1906).

ASSOCIATE MEMBERS

L. Adams, Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1943).
C. H. Anderson, Mgr., R. R. Sales Div., Armco Drainage & Metal Products, Inc., 206 Auditorium Bldg., Cleveland, Ohio, (1946).
W. P. Arnold, Asst. to V.-P. (Wood Preservg. Div.), Koppers Co., Inc., Pittsburgh, Pa., (1946).
C. Kenneth Avery, Dist. Mgr., B. J. Many Co., Inc., Francis Palms Bldg., Detroit, Mich., (1946).

G. H. Bailey, Mgr. R. R. Div., Morrison-Knudsen Co., 441 W. 5th St., Los Angeles, Calif., (1946).
D. L. Baker, V.-P., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
A. E. Bardwell, West. Div. Mgr., Fabreeka Products Co., 225 N. Wabash Ave., Chicago, (1946).
T. E. Bart, Designing Engr., The Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio, (1946).
K. T. Batchelder, The Insulite Co., 205 W. Wacker Dr., Chicago, (1938).
G. R. Betts, Mgr. R. R. Sales, Armco Drainage & Metal Prod., 310 S. Michigan Ave., Chicago, (1946).
D. B. Bishop, Sales Eng., Dearborn Chemical Co., 1512 Farmers Bank Bldg., Pittsburgh, Pa., (1946).
J. D. Bolton, Jno. D. Bolton & Co., 20 N. Wacker Dr., Chicago, (1946).
C. R. Boulton, R. R. Contractor, 10 E. Town St., Columbus, Ohio, (1946).
H. R. Boyd, Sargent & Boyd, 22839 Beech St., Dearborn, Mich., (1946).
E. S. Burford, V.-P., Consolidated Machinery & Supply Co., Ltd., 2031 Santa Fe Ave., Los Angeles, Calif., (1946).
A. C. Burhenn, Paint Engr., The Sherwin-Williams Co., 3170 E. Pico, Los Angeles, Calif., (1945).
J. P. Burkey, Con. Engr., Union Metal Mfg. Co., 2421 Plymouth Ave., Columbus, Ohio, (1942).

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J. E. Carroll, Mgr. Constr. Eqpt. Div., Harron Rickard & McCone Co. of Sou. Calif., 3850 Santa Fe Ave., Los Angeles, Calif., (1945).
K. H. Charlson, V.-P., Cunningham-Rudy Co., 3087 W. Grand Boul., Detroit, Mich., (1946).
K. J. Clapp, Asst. Sales Mgr., Homelite Corp., Port Chester, N. Y., (1946).
H. S. Claybaugh, Div. Engr. Armco Drainage & Metal Prod., Inc., 171 - 27th Ave., S. E., Minneapolis, Minn., (1946).
R. R. Clegg, Dist. Sales Mgr., American Lumber & Treating Co., 332 S. Michigan Ave., Chicago, (1946).
M. Coburn, Sales Engr., 3222 Washington Blvd., Indianapolis, Ind., (1946).
G. B. Coffey, R. R. Serv. Engr., A. M. Byers Co., 1217 Conway Bldg., Chicago, (1946).
C. M. Colvin, Constr. Supt., Armco Drainage & Metal Products, Inc., 7th & Parker Sts., Berkeley, Calif., (1945).
W. E. Crawford, Pres., George Vang, Inc., 623 Grant Bldg., Pittsburgh, Pa., (1946).
D. M. Crooks, Field Engr., Douglas Fir Plywood Assoc., 1707 Daily News Bldg., Chicago, (1946).
E. T. Cross, V.-P., Armco Drainage & Metal Producs, Inc., Middletown, Ohio, (1946).
T. D. Crowley, Pres., Thos. D. Crowley & Co., 6 N. Michigan Ave., Chicago, (1946).

V. W. Davis, Mgr., Railroad Sales, Armco Drainage & Metal Prod. Co., 122 Michigan Ave., Atlanta, Ga., (1946).
F. W. Dayton, Lundstrom & Skubic, Architects, 53 W. Jackson Blvd., Chicago, (1941).
G. E. Detzel, George E. Detzel Co., 2303 Gilbert Ave., Cincinnati, Ohio, (1945).
G. J. Diver, V.-P., Morrison Metalweld Process, Inc., 1437 Bailey Ave., Buffalo, N. Y., (1946).
F. J. Duffie, Gen. Supvr., Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
W. D. DuLac, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 544 New Center Bldg., Detroit, Mich., (1945).
K. O. Duncan, Duncan Hydraulic Roc-Jak, 1350 Wright St., Los Angeles 15, Calif., (1947)

C. R. Ehni, Lubr. Engr., The Texas Co., 4126 Bellefontaine Ave., Kansas City, Mo., (1945).
H. Eschenbrenner, Pres., Universal Concrete Pipe Co., 38 Ashbourne Rd., Columbus, Ohio, (1946).
F. W. Evinger, R. R. Repr., The Patterson Sargent Co., 1882 S. Normal Ave., Chicago, (1946).

J. D. Faylor, Constr. Supt., Armco Drainage & Metal Prod., Inc, 444 Insurance Exchange Bldg., Des Moines, Iowa, (1946).
P. Fields, Sales Div., Detroit Graphite Co., 3228 N. Broadway, St. Louis, Mo., (1946).
A. J. Filkins, 357 Conway Bldg., 111 W. Washington St., Chicago, (1927).
F. Fix, Sales Mgr., Transp. Dept. Cent. Div., Johns-Manville Sales Corp., 1530 Guild Hall Bldg., Cleveland, Ohio, (1946).
L. Flanagan, Detroit Graphite Co., 1500 S. Western Ave., Chicago, (1937).
A. O. French, Mgr. R. R. Sales, Mall Tool Co., 7740 S. Chicago Ave., Chicago, (1946).

L. E. Geerder, Supt., Geo. Vang, Inc., 623 Grant Bldg., Pittsburgh, Pa., (1946).

E. B. Hall, Jr., Oxweld R. R. Ser. Co., 230 N. Michigan Ave., Chicago, (1942).
R. W. Hastings, Hastings Signal & Equipment Co., Taunton, Mass., (1937).
R. J. Haxton, Sales Engr. Scotchlite Div., Minnesota Mining & Mfg. Co., 631 S. Anderson St., Los Angeles, Calif., (1946).
W. R. Hedden, Gen. Supt. of Constr., Roberts & Schaefer Co., 307 N. Michigan Ave., Chicago, (1946).
J. F. Hickey, Pres., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
R. R. Howard, Div. Mgr., Fabreeka Products Co., Inc., 6432 Cass Ave., Detroit, Mich., (1946).
D. A. Hultgren, David A. Hultgren Co., 80 E. Jackson Blvd., Chicago, (1945).

G. H. Jennings, Fowers-Thompson Const. Co., Joliet, Ill.
A. W. Johnson, Asst. Engr., Deleou & Cathers Co., 150 N. Wacker Dr., Chicago, (1942).
E. O. Johnson, Dist. Mgr., Bowser, Inc., Ft. Wayne, Ind., (1946).
E. R. Johnson, Harron, Rickard & McCone, 3850 Santa Fe Ave., Los Angeles, Calif., (1945).

J. E. Kalinka, Vice-Pres., Roberts & Schaefer Co., 307 N. Michigan Ave., Chicago, (1946).
B. D. Keatts, Reg. V.-P., Intrusion-Prepakt, Inc., 1978 Union Commerce Bldg., Cleveland, Ohio, (1946).

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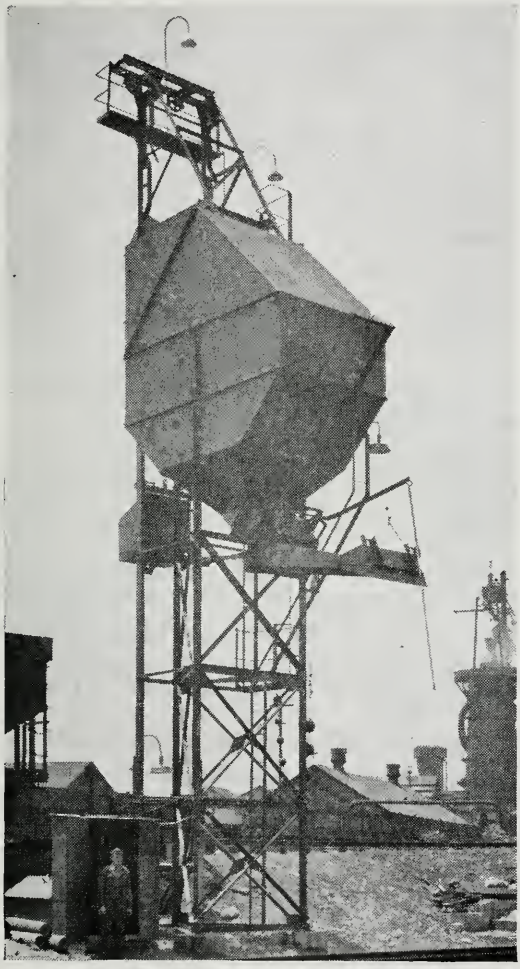

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G. D. Kemler, V.-P., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
A. L. Krukenberg, Water Well Supply (Pomona Pump Dealers), 2646 Norwalk Blvd., Norwalk, Calif., (1946).
F. H. Kuhlmann, Dist. Mgr., Dearborn Chemical Co., 1218 Oliver St., St. Louis, Mo., (1946).

J. W. Lacey, Gen. Supvr., The Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
D. A. Leach, Dist. Sales Mgr., Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago, (1946).
C. L. LeDuc, Field Sales Mgr., Acorn Refining Co., c/o Hotel DeSoto, St. Louis, Mo., (1946).
T. Lehon, V.-P. & Gen. Mgr., The Lehon Company, 4425 S. Oakley Ave., Chicago, (1937).
F. M. Lehrman, Engr., Reynolds Metals Co. (Ry. Suppl. Div.), 64 E. Jackson Blvd., Chicago, (1945).
F. Leypoldt, Jr., Pres., Carbolineum Wood Preserving Co., 528 W. Highland Ave., Milwaukee, Wis., (1945).
L. A. Luther, Serv. Engr., Ingersoll-Rand Co., 1121 Hamilton, Palo Alto, Calif., (1945).
C. A. Lyon, Dist. Mgr., Master Builders Co., 228 N. LaSalle St., Chicago, (1945).

B. J. Many, Pres., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
W. M. Marshall, Serv. Engr., Independent Pneumatic Tool Co., 355 Loma Ave., Long Beach, Calif., (1946).
C. L. Martin, c/o H. P. Martin & Sons, Box 475, Owensboro, Ky., (1946).
W. L. McDaniel, V.-P., Massey Concrete Products Co., 122 S. Michigan Ave., Chicago, (1945).
E. C. McFadden, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 10535 S. Wood St., Chicago, (1945).
E. J. McGehee, Vice-Pres. & Sales Mgr., Koppers Co., Inc. (Wood Pres. Div.), 700 Koppers Bldg., Pittsburgh, Pa., (1946).
G. P. McGreggor, Dist. Mgr., Panther Oil & Grease Co., 840 N. Main St., Ft. Worth, Tex., (1946).
C. J. McNally, Gen. Mgr., Cement Gun Co., Inc., 1520 Walnut St., Allentown, Pa., (1945).
C. A. McTaggart, State Sales Mgr., Armco Drainage & Metal Prod., Inc., 705 National Bank of S. D. Bldg., Sioux Falls, S. D., (1946).
G. McVay, 1317 Oak Ave., Evanston, Ill., (1937).
J. Wallace Miller, Pres., W-M Corp., 608 S. Dearborn St., Chicago, (1946).
H. K. Mills, Pres., Zitterell-Mills Co., Webster City, Iowa, (1946).
J. H. Minton, The Minton Construction Co., Swetland Bldg., Cleveland, Ohio, (1946).
H. Montgomery, Dist. Mgr., The Master Builders Co., 1340 E. 6th St., Los Angeles, Calif., (1946).
Z. J. Montgomery, Arco Co. of California, Ltd., Los Angeles, Calif., (1945).
W. Moorhead, Ser. Engr., Achorn Co., 1318 S. Main St., Los Angeles, Calif., (1946).
G. W. Morrow, Sales Mgr. R. R. Div., Worthington Pump & Machinery Corp., 400 W. Madison St., Chicago, (1945).
H. M. Morton, Sales Eng. R. R. Div., Johns-Manville Corp., 1207 Architects Bldg., Los Angeles, Calif., (1945).
H. Mull, V.-P. Sales, Warren Tool Corp., 2119 Bankers Bldg., Chicago, (1946).
R. J. Murdock, Vice-Pres., The Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio, (1946).

L. H. Needham, Vice-Pres., The Penetryn System, Inc., 2294 Scranton Rd., Cleveland, Ohio, (1946).
E. C. Neville, Dur-Ite Company, Toronto, Ont., Can., (1920).
W. L. Norman, Field Engr., Sullivan Machinery Div., Joy Mfg. Co., 2900 Santa Fe, Los Angeles, Calif., (1946).

P. A. Orton, Jr., V.-P., Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago, (1946).
H. F. Ostendorf, 243 E. Second St., Dayton, Ohio, (1936).
R. I. Oswald, Lubr. Engr., The Texas Co., 141 D So. Canon Dr., Beverley Hills, Calif., (1945).

G. H. Paris, R. R. Repr., Portland Cement Assoc., 33 W. Grand Ave., Chicago, (1945).
R. Patterson, Vice-Pres., Intrusion-Prepakt, Inc., 309 W. Jackson Blvd., Chicago, (1946).

C. C. Rausch, Asst. Vice-Pres., Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, (1945).
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H. H. Richardson, Asst. Vice-Pres., National Aluminate Corp., 6216 W. 66th Pl., Chicago, (1941).
H. E. Robertson, Mgr., The Robertson Co., 730 E. Gage St., Los Angeles, Calif., (1946).
W. O. Robertson, Div. Sales Engr., Armco Drainage & Metal Prod., Inc., Box 1657, Baltimore, Md., (1946).
L. R. Robinson, Pres., Pittsburgh Pipe Cleaner Co., 2943 Belrose Ave., Pittsburgh, Pa., (1945).
W. H. Rockefeller, Insulation Engr. & Contract Mgr., Marine Engineering & Supply Co., 941 E. 2nd St., Los Angeles, Calif., (1946).
O. C. Rome, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).

B. H. Sargent, Sargent & Boyd, 22839 Beech St., Dearborn, Mich., (1946).
O. M. Saxton, Dist. Chgo. Mgr., Timber Structures, Inc., 120 S. LaSalle St., Chicago, (1945).
J. M. Scott, The Arco Co., 614 Delaware St., Scranton, Penna., (1945).
J. F. Seiler, Prin. Engr., Ser. Bur.-American Wood Preservers Assn., 111 W. Washington St., Chicago, (1931).
J. W. Shoop, Mgr. R. R. Sales Dept., The Lehon Co., 4425 S. Oakley Ave., Chicago, (1945).
J. E. Simkins, Mgr., Jas. E. Simkins, 5408 S. Western Ave., Los Angeles, Calif. (1945).
* **M. P. Smith,** Joyce-Cridland Co., Dayton, Ohio, (1937).
B. S. Snow, Pres., T. W. Snow Construction Co., 9 S. Clinton St., Chicago, (1946).
C. E. Southwick, Homelite Corp., (Port Chester, N. Y.), 624 S. Anderson, Los Angeles, Calif., (1945).
P. C. Spears, Vice-Pres., General Dredging Co., Inc., 220 LaFontain St., Ft. Wayne, Ind., (1946).
G. W. Stierer, Mgr., Structural Steel Dept., Robert W. Hunt Co., 175 W. Jackson Blvd., Chicago. (1946).
W. J. Storen, Jr., Pres., W. J. Storen Co., 2411 - 14th St., Detroit, Mich., (1946).
L. O. Stratton, Lloyds Ry. Supplies, 227 U. S. Natl. Bank Bldg., Denver, Colo. (1947).

W. C. Thatcher, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).
N. Thompson, V.-P., Homelite Corp., Port Chester, N. Y., (1946).
J. W. Todd, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 3034 Washington Ave., St. Louis, Mo., (1945).
R. N. Tracy, Mgr. R. R. Sales, Hardesty Div., Armco Drainage & Metal Products, Inc., Denver, Colo., (1946).
F. W. Truss, Sales Engr., Armco Drainage & Metal Prod., Inc., 815 Ambassador Bldg., St. Louis, Mo., (1946).

F. S. Ulrich, Ind. Mgr., Sherwin-Williams Co., 1450 Sherman Ave., Oakland, Calif., (1946).

R. G. VandenBoom, Pres. & Treas., Pacific Union Metal Co., P. O. Box 2616, Terminal Annex, Los Angeles, Calif., (1946).
R. J. Voss, Automatic Nut Co., Inc., 310 S. Michigan Ave., Chicago, (1940).

R. Wagner, Asst. Gen. Supt. of Constr., Roberts & Schaefer Co., 301 N. Michigan Ave., Chicago, (1946).
R. W. Walb, Pres., General Dredging Co., Inc., 2200 LaFontain St., Ft. Wayne, Ind., (1946).
V. E. West, Pres., Stacco Products, Inc., 1207 - 19th Ave., Oakland, Calif., (1946).
B. E. Whipple, Sales Eng., Pacific Union Marbelite Co., 3248 Long Beach Ave., Los Angeles, Calif., (1946).
E. R. Williams, Pres., Williams Waterproofing & Painting Co., 707 Heliotrope Dr., Los Angeles, Calif., (1945).
E. R. Wolf, Sales Engr., Marine Engineering & Supply Co., 941 E. 2nd St., Los Angeles, Calif., (1946).
B. R. Wood, c/o The Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio, (1937).

R. W. Young, Jr., R. W. Young Mfg. Co., 20 N. Wacker Dr., Chicago, (1946).

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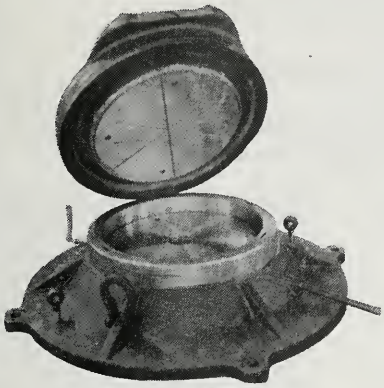

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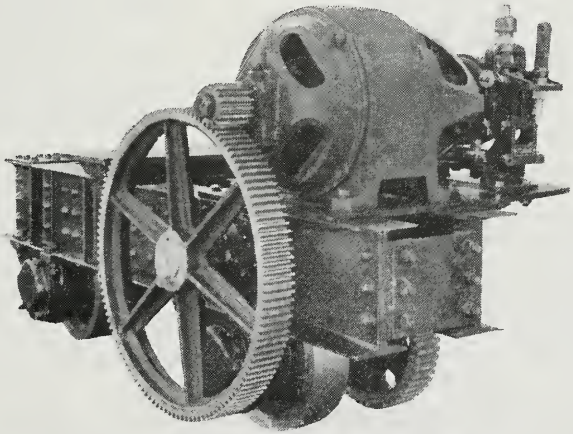

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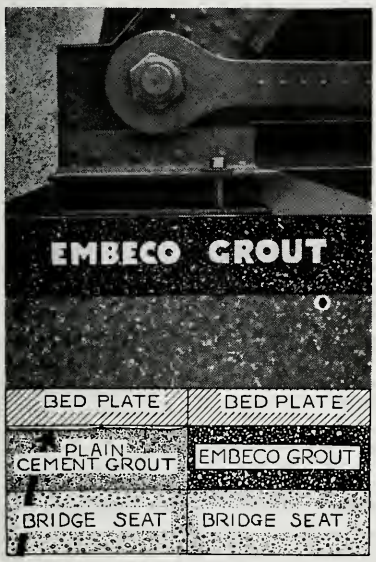

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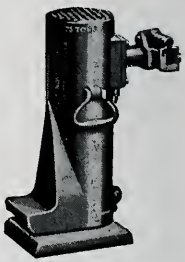

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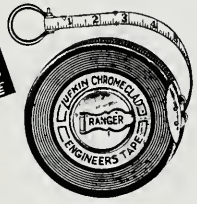

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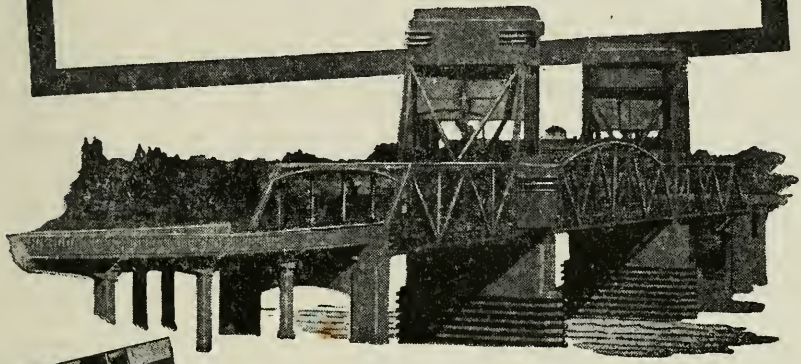

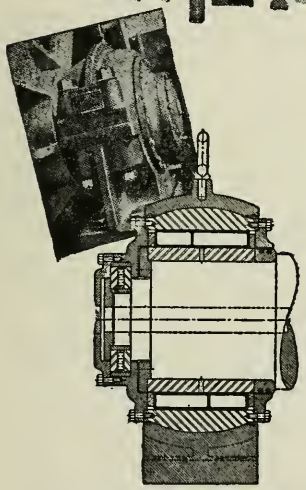

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